NSW GOVERNMENT | Transport for NSW

25 March 2021

Mr Anthony Witherdin
Director, Key Sites Assessments
NSW Department of Planning, Industry and Environment
4 Parramatta Square
12 Darcy Street,
Parramatta NSW 2150

Attention: Ms Amy Watson
Via email: amy.watson@planning.nsw.gov.au

Dear Amy,

Re: DA 10082 - New Digital Advertising Signage Church Street overpass Burns Bay Road, Hunters Hill.

I refer to our application DA10082 which was lodged with the Department of Planning Industry and Environment in October 2019 seeking development consent to install two digital advertising signs on Church Street Overpass, Hunters Hill.

As discussed we would like to submit amended DA plans for consideration as follows:

1. The removal of the proposed Sign No.1 (inbound) over the Southbound carriageway on the Northern Elevation. Accordingly, the amended proposal would reduce the total signage area by 50% and retain Sign No.2 (outbound) on the Southern Elevation. To this end, amended drawings, DS2019/000865 General Arrangement Sheets 1 and 2, are attached.

Please do not hesitate to contact me if you would like to discuss or require further clarification.

If you have any further questions, I would be pleased to take your call on 0415 505 566.

Yours sincerely,

Barry Newling
Principal Manager Commercial
Customer Strategy and Technology

Transport for NSW
27-31 Argyle Street, Parramatta NSW 2150 | Locked Bag 973, Parramatta NSW 2124
W transport.nsw.gov.au | ABN 18 804 239 602

CHURCH STREET OVERPASS HUNTERS HILL

Advertising Signage Structural Feasibility Assessment

Structural Calculations

CLIENT

JCDecaux

DATE

18th March 2021

REFERENCE NO.

10032068-02

REVISION

2

Executive Summary

Arcadis have undertaken a structural feasibility assessment of the existing Church Street overpass at Hunter Hill to determine the structural adequacy of the existing bridge to support the introduction of new advertising signage.

It is proposed that the advertising signage structure will be attached to the existing bridge superstructure over the northbound carriageway of Burns Bay Road (refer Figure 1).

The signage structure is commonly referred to as a 'Supersite' having a nominal face size of 12.66 metres long x 3.35 metres high and will be purpose-designed and fabricated to accommodate a digital screen, including all ancillary components, such as digital controllers and an electrical distribution board. For the objective of our assessment we have allowed for a generic digital display unit with a nominal weight of 54kg/m^2.

The structural feasibility assessment confirms that the existing bridge is capable of supporting the introduction of the new digital advertising sign.

The exact nature of the advertising signage attachment methodology will be established during the construction design and documentation phase of the project, during which time, additional checks will be carried out on localised anchorage of the support framing, and a fatigue assessment.

Figure 1 - Locality Plan

ARCADIS	STRUCTURAL CALCULATIONS	DOCUMENT No

OFFICE	PROJECT TITLE
Manila	Church Street Bridge, Hunters Hill

SUBJECT	SHEET No
Bridge Assessment	

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	54	JBB	20-Aug-19					
2	56	JBB	17-Mar-21					Added stability checks for out-of-balance scenario
3								

SUPERSEDES DOC No	DATE

CONTENTS

A. ASSESSMENT SUMMARY

A.1 DESIGN METHODOLOGY

1. The assessment of an existing bridge due to the additional loads from the digital signage structure is done using ETABS 17 software. The framing and section properties of the bridge is based on the bridge drawings provided.
2. Digital signage is to be installed on one side of the bridge. Using Microstran software, the framing and section properties of the signage were specified. The model was mostly comprised of a combination of RHS and SHS sections welded to each other.
3. Using the Section Designer of ETABS 17, the girder of the bridge was modelled and member forces were obtained.The girder was then checked manually for combined shear and torsion.
4. Ultimate bending and deflection were analysed using RAPT 6.5.
5. Using manual calculations, stability checks (sliding and overturning) were done to check the out-of-balance loading scenario when only one sign structure is installed.

A.2 ASSUMPTIONS

1. The supports and connections of the sign box structure to the bridge was only assumed since there is no details yet for these. To compensate, the summation of the reaction force was transferred to the girder which induces additional moment.
2. It was assumed that the location from the outer edge of the bridge girder to the signboard is equal to 250mm.
3. The section that was considered is just a portion of the girder where the signboard will be attached for simplicity of analysis and conservative purposes.
4. The prestressing force per strand was assumed to be equal to 124.38 kN which is the default value from RAPT.
5. An idealized section was used with a lesser moment of inertia compared to the original cross section due to the limitation of RAPT in modelling irregular cross section.
6. To generate accurate deflections, a correction factor was used for the deflection calculated in RAPT to incorporate the actual moment of Inertia of the girder taken from Section Designer results generated from ETABS.

A.3 SUMMARY OF RESULTS

1. After performing shear and torsion check following AS 5100.7 considering prestressing force mentioned in the assumptions, results showed that the spacing of the torsional reinforcement is adequate and additional shear reinforcement is not needed.
2. Following the results from RAPT, additional top reinforcement bars are required. However, these additional bars can be ignored since these are the required bars during construction (prestressing). The installation of the sign board does not require additional reinforcements at the top and bottom portion of the girder.
3. The loads from the signboard produces an additional moment equal to 650kNm and deflection equal to 11.6 mm,
4. Following AS 5100.2 standard, the deflection allowed for a simply supported bridge is span length /600. Considering the spans of the Church Street Bridge, the allowable deflection is limited to 74.275 mm. Accounting the correction factor for the deflection, the maximum long term deflection that was observed is equal to 58.83 mm. Hence, bridge deflection is still within the limit.
5. Using AS1170.0 Section 4.2.1 Stability Load Combinations, Stability checks for overturning and sliding give passing results. (Factor of safety equal to 129 and 11, respectively)

A.3 SUMMARY OF RESULTS (cont.)

The portion of the bridge girder was assessed to be capable of supporting the inclusion of the proposed signage structures and the existing pedestrian loads. Take note that the prestressing force used was taken from the default value given by RAPT. Shear and torsion check should be reassessed using the actual prestressing forces if data is available. This assessment did not consider application vibration loads and fatigue loads, since it was assumed that these cases were considered during the original design of the bridge.

Additional stability check was done due to updates from the original plan of installing signage to opposite sides of the bridge. It was advised that signage is to be installed on one side of the bridge only and due to unbalanced loading, stability against overturning and sliding was done, giving factors of safety of 129 and 11, respectively using AS1170.0 Section 4.2.1 load combinations.

Before installation of the new sign, the following items should also be taken into account:
1. Connection points should be checked locally once there is already scheme on how to connect with the sign.
2. Recheck anchorage of sign support connection to bridge girder.
3. Perform fatigue assessment during sign structure design.

B. PROPERTIES

Concrete		**Steel**	
Compressive Strength, f'c	40 MPa	Yield strength, fy	400 MPa
Possion's ratio, v (assumed)	0.2	Modulus of Elasticity, Es	200000 MPa
Unit weight	25.5 kN/m^3		
Modulus of Elasticity, Ec	32800 MPa		

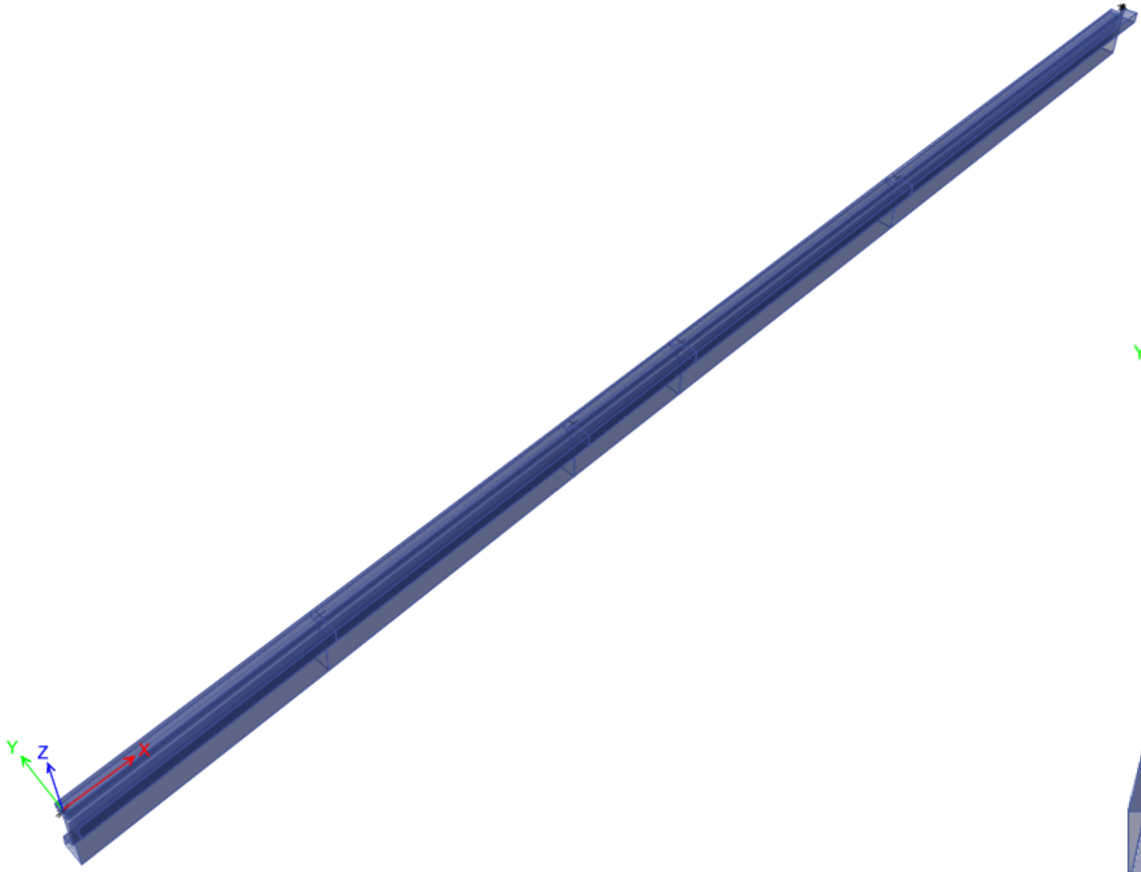
C. LOAD FACTORS AND LOAD COMBINATIONS

Load factors are taken from AS 5100.7 while load combinations are based on AS 5100.2 requirements. Refer to G.1 for the load combinations used.

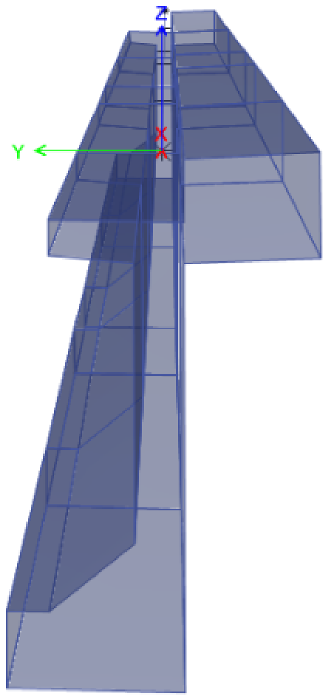
D. DESIGN CODES AND REFERENCES

AS 1170.0-2002	Structural design actions - Part 0: General Principles
AS/NZS 1170.2-2011	Structural design actions - Part 2: Wind actions
AS 1657-2013	Fixed platforms, walkways, stairways and ladders -Design, construction and installation
AS 5100.2:2017	Bridge design - Part 2 : Design Loads
AS/NZS 5100.5:2017	Bridge design - Part 5 : Concrete
AS 5100.7:2017	Bridge design - Part 7 : Bridge Assessment

E. Structure Geometry



ETABS MODEL

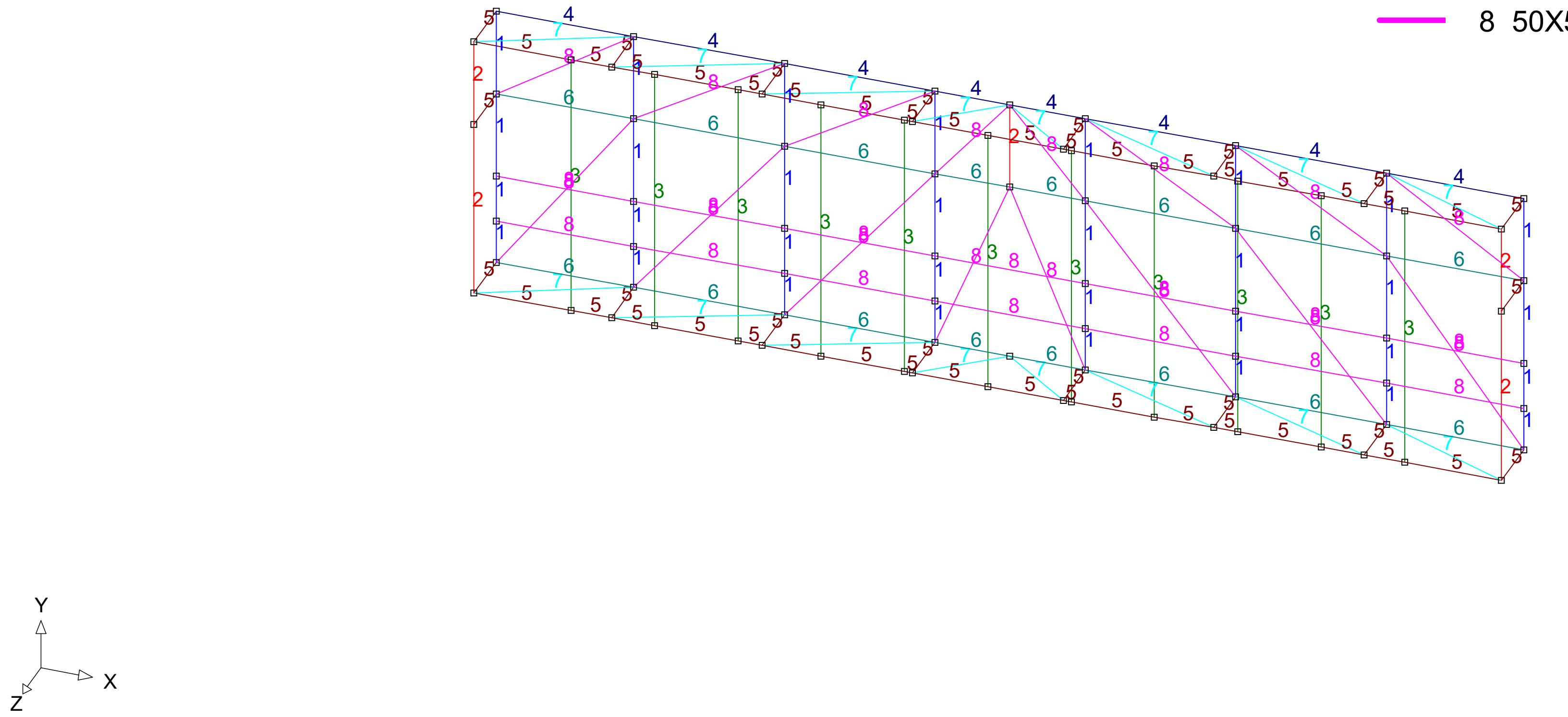


(EQUIVALENT GIRDER SECTION)

E. Structure Geometry

Sections:

1	100X100X5.0SHS Y
2	75X75X5.0SHS Y
3	75X50X5.0RHS Y
4	100X100X5.0SHS Y
5	75X75X5.0SHS Y
6	200X100X5.0RHS Y
7	50X50X4.0SHS Y
8	50X50X4.0SHS Y



theta: 290 phi: 30

ASSUMED SIGNBOX GEOMETRY

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{1000}	=	42.001	m/s for Mzcat = 0.9131
Serviceability Design Wind Speed, V_{25}	=	33.783	m/s
Wind Region	=	A2	
Topographic Multiplier, M_t	=	1	
Shielding Multiplier, M_s	=	1	
Terrain Category	=	2.5	
Importance Level	=	3	
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability

Direction Multiplier, M_d

Wind Direction	Md
N	0.8
NE	0.8
E	0.8
SE	0.95
S	0.9
SW	0.95
W	1
NW	0.95

Use M_d = 1

Cfig = Cp,n

Cdyn = 1.0

ok

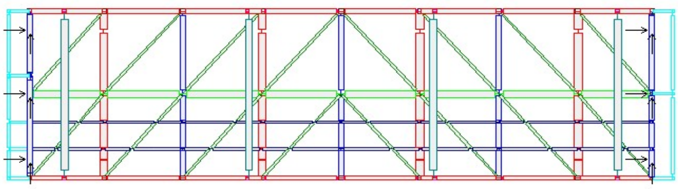
At θ = 0,

height from ground, h = 9.785

b = 12.63

b/c = 3.77

c/h = 0.34



c = 3.35

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND NORMAL TO HOARDING OR WALL, $\theta = 0°$

b/c	c/h	$C_{p,n}$	e
0.5 to 5	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	0
>5		$1.7 - 0.5\ c/h$	0
all	<0.2	$1.4 + 0.3\log_{10}(b/c)$	0

Cp,n = $1.3 + 0.5\ (0.3 + \log_{10}(b/c))(0.8 - c/h)$

Cp,n = 1.51

WIND PRESSURES $p = (0.5\ \rho_{air})\ [V_{des,\theta}]^2\ C_{fig}\ C_{dyn}$

Puls = 0.5 * 1.2 * 42.00099 ^2 * 1.0 * 1.51 — Wind pressure for Ultimate Limit State

Puls = **1.60** kPa

Psls = 0.5 * 1.2 * 33.783405 ^2 * 1.0 * 1.51 — Wind pressure for Service Limit State

Psls = **1.03** kPa

Wind Loading (AS/NZS 1170.2 : 2011)

MICFROSTRAN INPUT FOR WIND LOAD (W_U)

*at cladding

Puls (kPa)	Span (m)	Line Load (kN/m)
1.60	1.024	**1.637**
1.60	1.1095	**1.774**
1.60	0.598	**0.955**

MICFROSTRAN INPUT FOR WIND LOAD (W_S)

Psls (kPa)	Span (m)	Line Load (kN/m)
1.03	1.024	**1.059**
1.03	1.1095	**1.148**
1.03	0.598	**0.618**

WIND LOAD AT EXPOSED FRAMES

Cf = 1.2 = Cfig

$$p = (0.5\ \rho_{air})\ [V_{des,\theta}]^2\ C_{fig}\ C_{dyn}$$

Puls = 0.5 * 1.2 * 42.00099 ^2 * 1.0 * 1.2 — Wind pressure for Ultimate Limit State

Puls = **1.27** kPa

Psls = 0.5 * 1.2 * 33.783405 ^2 * 1.0 * 1.2 — Wind pressure for Service Limit State

Psls = **0.82** kPa

MICFROSTRAN INPUT FOR WIND LOAD (W_U) AT EXPOSED FRAMES

*at exposed frames:

Puls (kPa)	Width (m)	Line Load (kN/m)
1.27	0.2	**0.26**
1.27	0.1	**0.13**
1.27	0.075	**0.1**
1.27	0.05	**0.07**

MICFROSTRAN INPUT FOR WIND LOAD (W_S) AT EXPOSED FRAMES

*at exposed frames:

Psls (kPa)	Width (m)	Line Load (kN/m)
0.82	0.2	**0.17**
0.82	0.1	**0.09**
0.82	0.075	**0.07**
0.82	0.05	**0.05**

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND AT 45° TO HOARDING OR WALL, θ = 45°

b/c	c/h	$C_{p,n}$	e
0.5 to 5 inclusive	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	$0.2b$
	<0.2	$1.4 + 0.3\log_{10}(b/c)$	$0.2b$

Positive eccentricity

MICROSTRAN INPUT FOR WIND LOAD (W_U)

*at cladding

w_u = 1.60 kPa

w_{1u} = 0.32 kPa

w_{2u} = 2.88 kPa

Puls (kPa)	Width (m)	Line Load (kN/m)
0.32	0.598	**0.191**
0.32	1.1095	**0.355**
0.32	1.024	**0.327**
0.32 & 2.88	1.024	**1.637**
2.88	1.024	**2.946**
2.88	1.1095	**3.192**
2.88	0.598	**1.720**

MICROSTRAN INPUT FOR WIND LOAD (W_S)

w_u = 1.03 kPa

w_{1u} = 0.21 kPa

w_{2u} = 1.86 kPa

Psls (kPa)	Width (m)	Line Load (kN/m)
0.21	0.598	**0.124**
0.21	1.1095	**0.229**
0.21	1.024	**0.212**
0.21 & 1.86	1.024	**1.059**
1.86	1.024	**1.906**
1.86	1.1095	**2.065**
1.86	0.598	**1.113**

	DOCUMENT No	SHEET
ARCADIS		
SUBJECT	(DIGITAL SIGN) LOAD CALCULATION	
REFERENCE		

Negative eccentricity

MICROSTRAN INPUT FOR WIND LOAD (W_U)

*at cladding

w_u = 1.60 kPa
w_{1u} = 2.88 kPa
w_{2u} = 0.32 kPa

Puls (kPa)	Width (m)	Line Load (kN/m)
2.88	0.598	**1.720**
2.88	1.1095	**3.192**
2.88	1.024	**2.946**
2.88 & 0.32	1.024	**3.276**
0.32	1.024	**0.327**
0.32	1.1095	**0.355**
0.32	0.598	**0.191**

MICROSTRAN INPUT FOR WIND LOAD (W_S)

w_u = 1.03 kPa
w_{1u} = 1.86 kPa
w_{2u} = 0.21 kPa

Psls (kPa)	Width (m)	Line Load (kN/m)
1.86	0.598	**1.113**
1.86	1.1095	**2.065**
1.86	1.024	**1.906**
1.86 & 0.21	1.024	**2.119**
0.21	1.024	**0.212**
0.21	1.1095	**0.229**
0.21	0.598	**0.124**

ARCADIS	DOCUMENT No	SHEET
SUBJECT	(DIGITAL SIGN) LOAD CALCULATION	
REFERENCE		

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND PARALLEL TO HOARDING OR WALL, $\theta = 90°$

b/c	c/h	Distance from windward free end	$C_{p,n}$ (see Note)
All	≤0.7	0 to 2c	±1.2
		2c to 4c	±0.6
		>4c	±0.3
	>0.7	0 to 2h	±1.0
		2h to 4h	±0.25
		>4h	±0.25

Cf = 1.2 = Cfig

$$p = (0.5\,\rho_{air})\,[V_{des,\theta}]^2\,C_{fig}\,C_{dyn}$$

Puls = 0.5 * 1.2 * 42.00099 ^2 * 1.0 * 1.2 — Wind pressure for Ultimate Limit State

Puls = **1.27** kPa

Psls = 0.5 * 1.2 * 33.783405 ^2 * 1.0 * 1.2 — Wind pressure for Service Limit State

Psls = **0.82** kPa

MICROSTRAN INPUT FOR WIND LOAD (W_U)

*at cladding

Puls (kPa)	Point	Line Load (kN/m)
1.27	0.2	**0.26**
1.27	0.1	**0.13**
1.27	0.075	**0.1**
1.27	0.05	**0.07**

MICROSTRAN INPUT FOR WIND LOAD (W_S)

Psls (kPa)	Point	Line Load (kN/m)
0.82	0.2	**0.17**
0.82	0.1	**0.09**
0.82	0.075	**0.07**
0.82	0.05	**0.05**

ARCADIS	DOCUMENT No	SHEET
SUBJECT	(DIGITAL SIGN) LOAD CALCULATION	
REFERENCE		

LIVE LOAD, Q

THE STRUCTURAL COMPONENTS DETAILED ON THESE STRUCTURAL DRAWINGS HAVE BEEN DESIGNED FOR THE FOLLOWING APPLIED LOADINGS.

FLOOR USAGE	LIVE LOAD (kPa)	ALLOWANCE FOR SUPERIMPOSED DEAD LOAD (kPa)
GANTRY	2.5	-

MICFROSTRAN INPUT FOR FLOOR LIVE LOAD (Q)

Q (kPa)	Span (m)	Line Load (kN/m)
2.50	0.845	2.113
2.50	1.77	4.425
2.50	1.85	4.625

LIVE LOAD FOR LADDER = 1.5kN

SUPERIMPOSED DEAD LOAD (SDL)

SDL FOR FLOOR MESH = 40kg/m^2 = 0.4kPa

*at floor

SDL (kPa)	Span (m)	Line Load (kN/m)
0.40	0.845	0.338
0.40	1.77	0.708
0.40	1.85	0.74

SDL FOR SIGN = 54kg/m^2 = 0.54kPa

SDL (kPa)	Span (m)	Line Load (kN/m)
0.54	1.024	0.553
0.54	1.1095	0.6
0.54	0.598	0.323

SDL FOR HANDRAIL = 0.35kN/m or 0.6kN

SDL FOR CLADDING = 20kg/m^2 = 0.2kPa

SDL (kPa)	Span (m)	Line Load (kN/m)
0.200	0.3	0.06

G. MICROSTRAN INPUT

G.1 LOAD CASES AND COMBINATIONS

Case	Type	Analysis Type	Flag	Title
1	P	N	-	SW
2	P	N	-	SDL
3	P	N	-	Q
4	P	N	-	Wu +Z
5	P	N	-	Wu -Z
9	P	N	-	Wu +Z - 45 e+ (Ultimate Wind at +Z-dir)
10	P	N	-	Wu +Z - 45 e- (Ultimate Wind at +Z-dir)
11	P	N	-	Wu -Z - 45 e+(Ultimate Wind at -Z-dir)
12	P	N	-	Wu -Z - 45 e-(Ultimate Wind at -Z-dir)
13	P	N	-	Wu +X (Ultimate Wind at +X-dir)
14	P	N	-	Wu -X (Ultimate Wind at -X-dir)
60	P	N	-	PNW (Natural Wind Gust Fatigue Load)
61	P	N	-	PTG (Truck-Induced Gust Fatigue Load)

LOAD COMBINATIONS

== L O A D   C A S E S ==

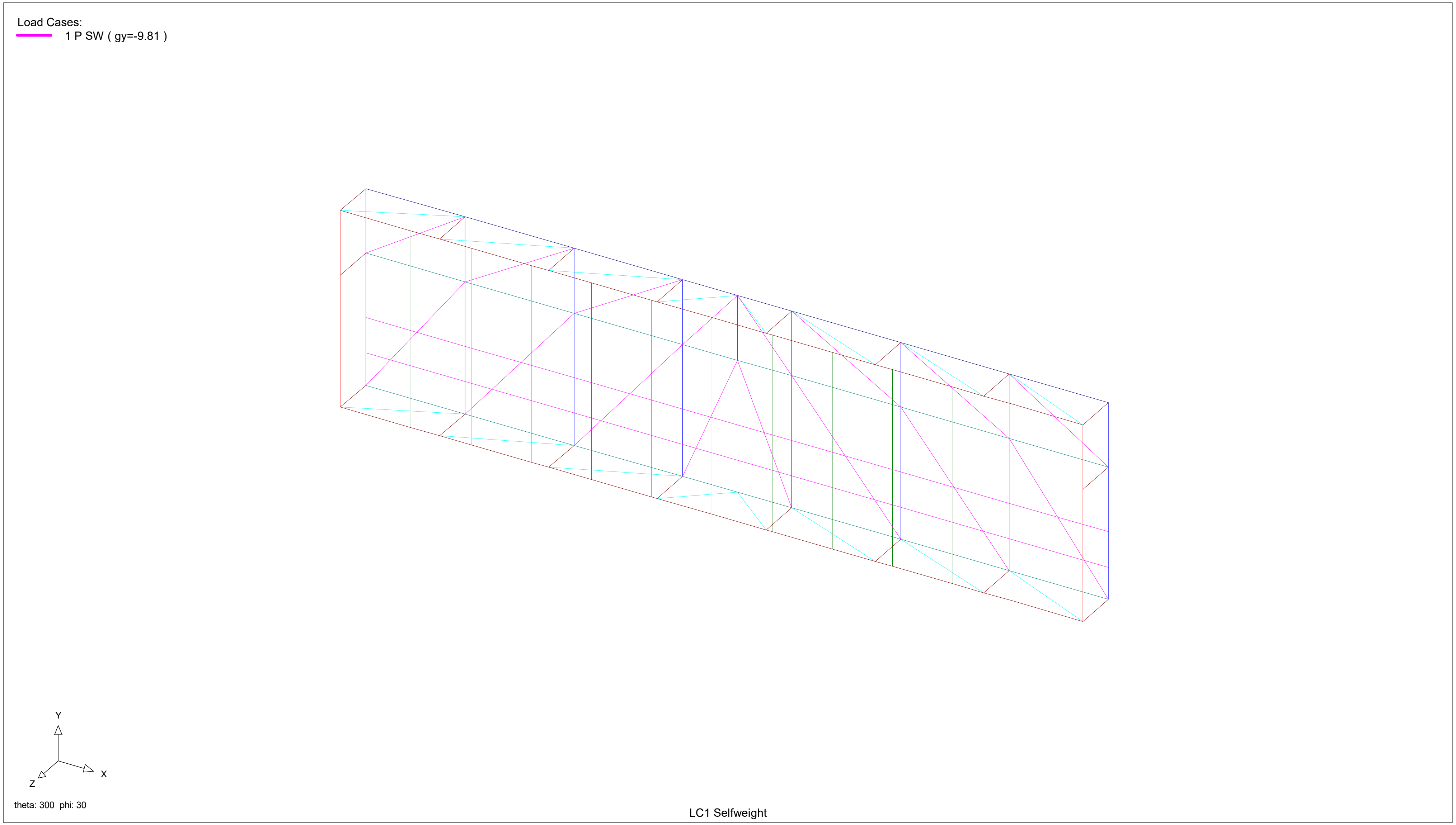
Case	Type	Type	Flag	Title
6	C	N	-	Ws +Z
7	C	N	-	Ws -Z
8	C	N	-	G (SW + SDL)
15	C	N	-	Ws +Z - 45 e+ (Service Wind at +Z-dir)
16	C	N	-	Ws +Z - 45 e- (Service Wind at +Z-dir)
17	C	N	-	Ws -Z - 45 e+ (Service Wind at -Z-dir)
18	C	N	-	Ws -Z - 45 e- (Service Wind at -Z-dir)
19	C	N	-	Ws +X (Service Wind at +X-dir)
20	C	N	-	Ws -X (Service Wind at -X-dir)
21	C	N	-	ULS1: 1.2G + 1.5Q
22	C	N	-	ULS2: 0.9G + Wu (+Z)
23	C	N	-	ULS3: 0.9G + Wu (-Z)
24	C	N	-	ULS4: 1.2G + Wu (+Z)
25	C	N	-	ULS5: 1.2G + Wu (-Z)
26	C	N	-	ULS6: 0.9G + Wu (+Z) 45e+
27	C	N	-	ULS7: 0.9G + Wu (+Z) 45e-
28	C	N	-	ULS8: 0.9G + Wu (-Z) 45e+
29	C	N	-	ULS9: 0.9G + Wu (-Z) 45e-
30	C	N	-	ULS10: 1.2G + Wu (+Z) 45e+
31	C	N	-	ULS11: 1.2G + Wu (+Z) 45e-
32	C	N	-	ULS12: 1.2G + Wu (-Z) 45e+
33	C	N	-	ULS13: 1.2G + Wu (-Z) 45e-
34	C	N	-	ULS14: 0.9G + Wu (+X)
35	C	N	-	ULS15: 0.9G + Wu (-X)
36	C	N	-	ULS16: 1.2G + Wu (+X)
37	C	N	-	ULS17: 1.2G + Wu (-X)
51	C	N	-	SLS1: G + Q
52	C	N	-	SLS2: G + Ws (+Z)
53	C	N	-	SLS3: G + Ws (-Z)
54	C	N	-	SLS4: G + Ws (+Z) e+
55	C	N	-	SLS5: G + Ws (+Z) e-
56	C	N	-	SLS6: G + Ws (-Z) e+
57	C	N	-	SLS7: G + Ws (-Z) e-
58	C	N	-	SLS8: G + Ws (+X)
59	C	N	-	SLS9: G + Ws (-X)

G.2 LOAD VALUES

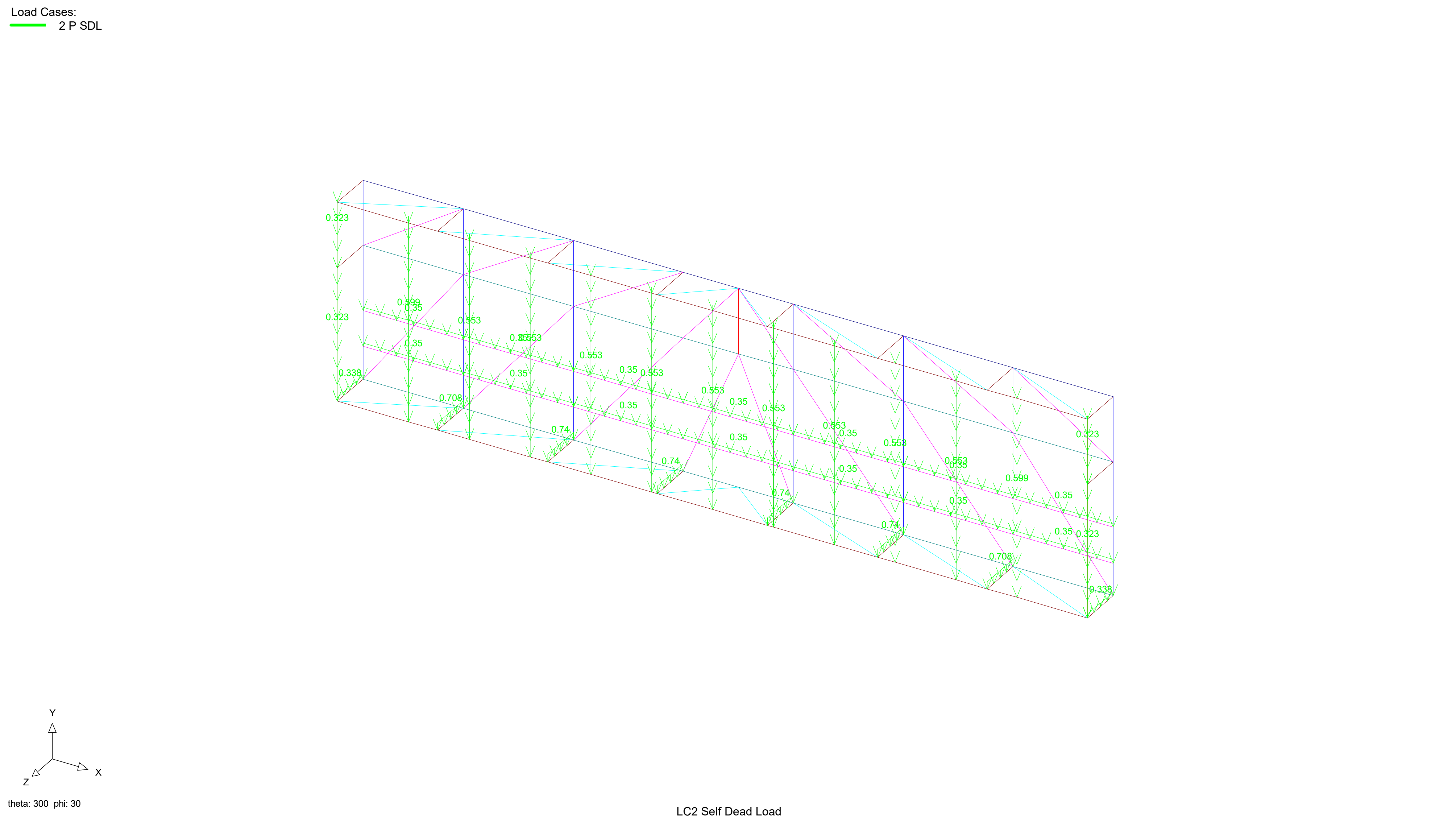
Microstran V9

pilongoh5706
Job: Hunters Hill Bridge Signage c 08072019 (with supports)
Kingsford Smith Drive

13/08/2019
10:48:01 AM

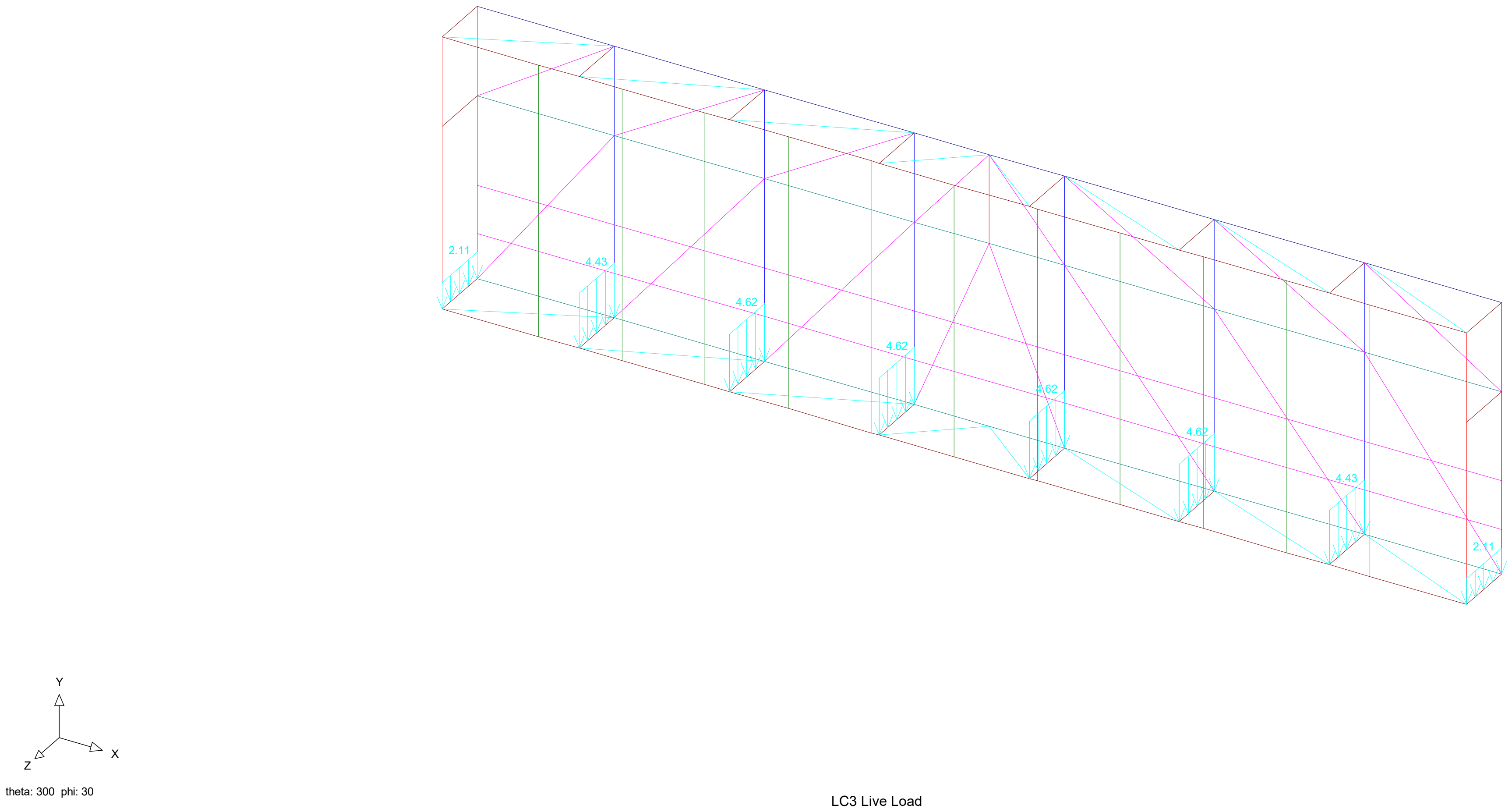


LC1 Selfweight

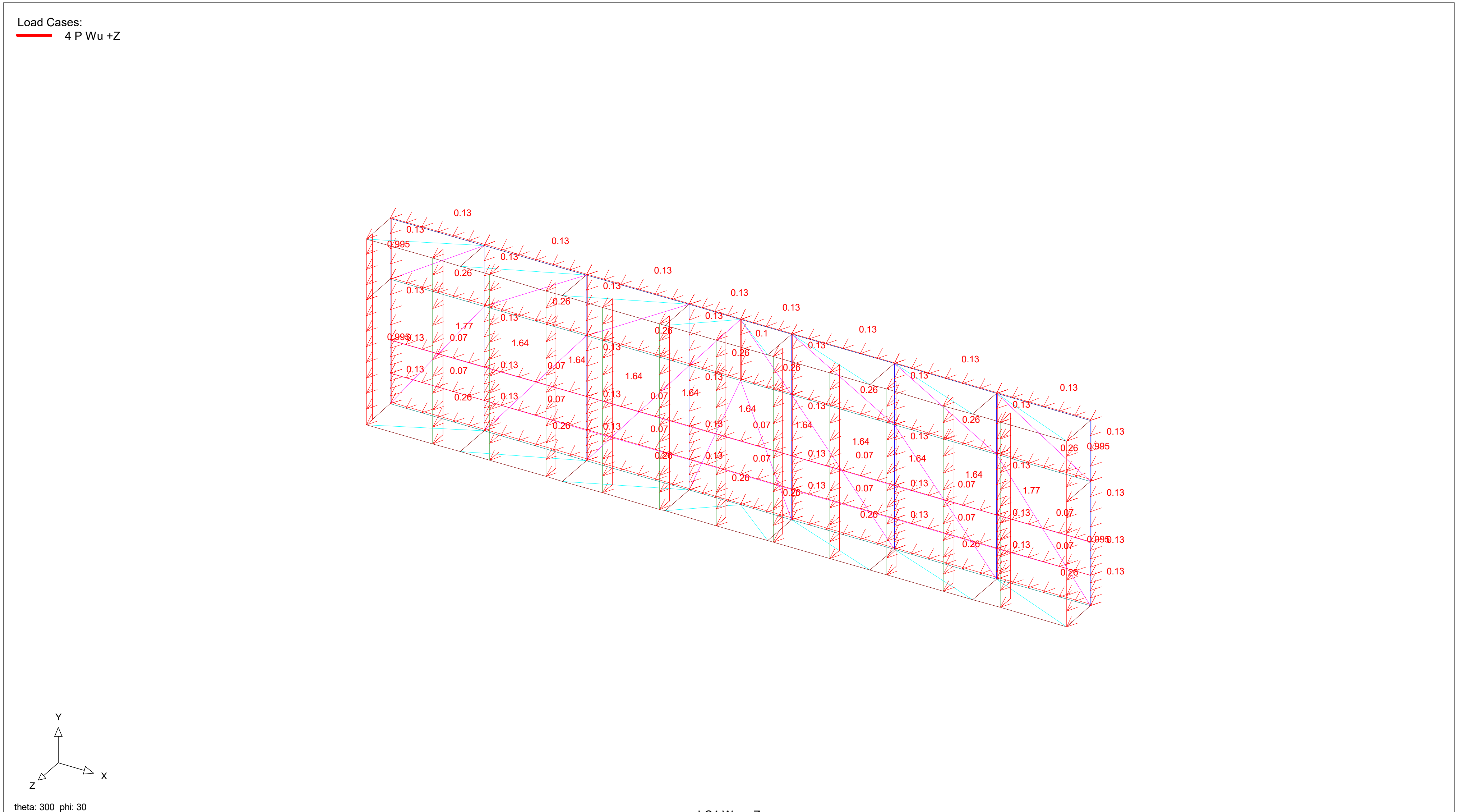


LC2 Self Dead Load

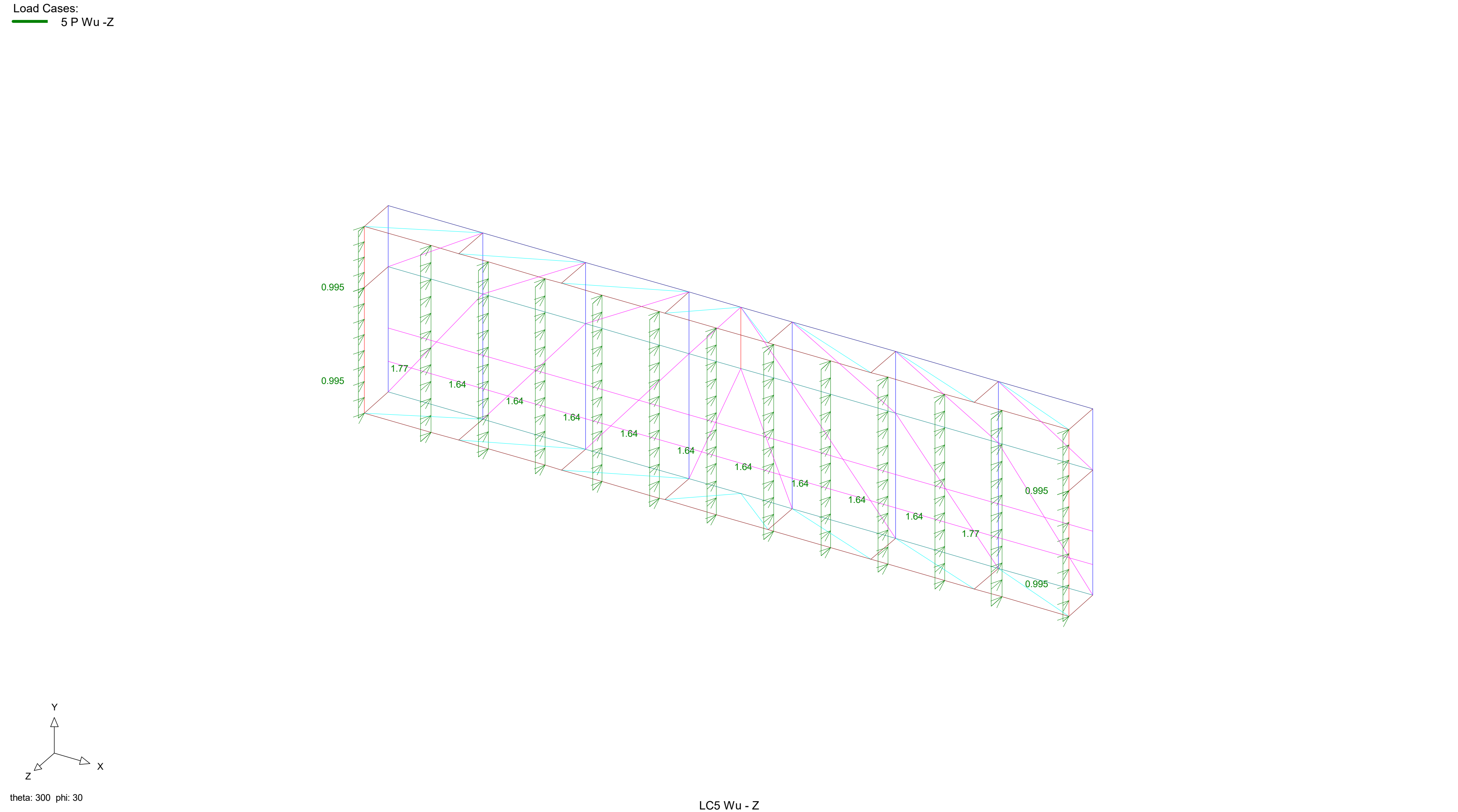
Load Cases:
3 P Q



LC3 Live Load



LC4 Wu + Z


Load Cases:
5 P Wu -Z
0.995
0.995
1.77
1.64
1.64
1.64
1.64
1.64
1.64
1.64
1.64
1.64
1.77
0.995
0.995
Y
X
Z
theta: 300 phi: 30

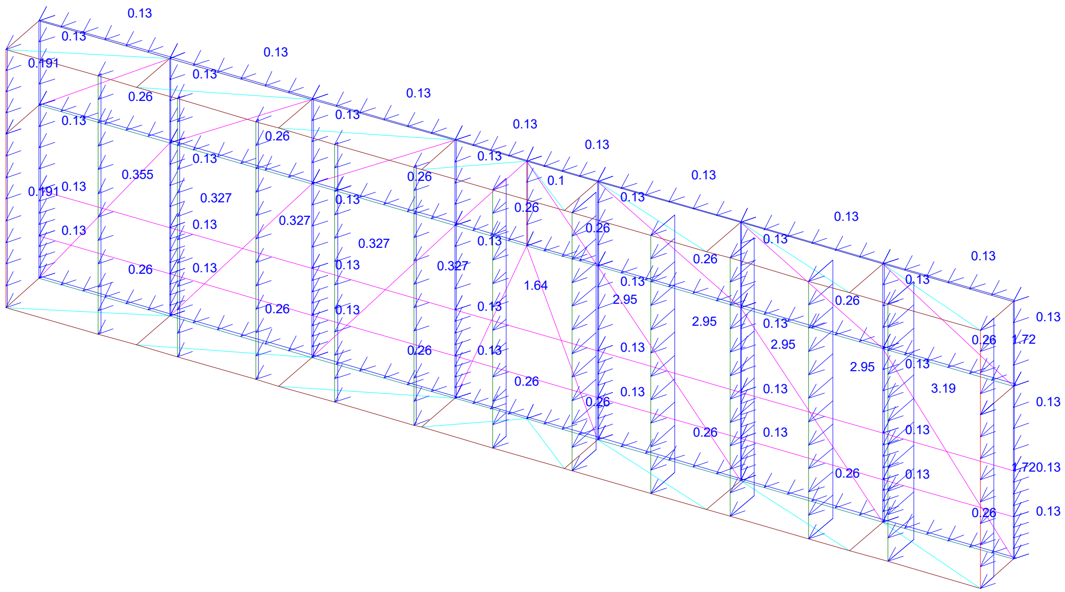
LC5 Wu - Z

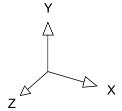
Microstran V9

pilongoh5706
Job: Hunters Hill Bridge Signage c 08072019 (with supports)
Kingsford Smith Drive

13/08/2019
10:54:32 AM

Load Cases:
9 P Wu +Z - 45 e+ (Ultimate Wind at +Z-dir)

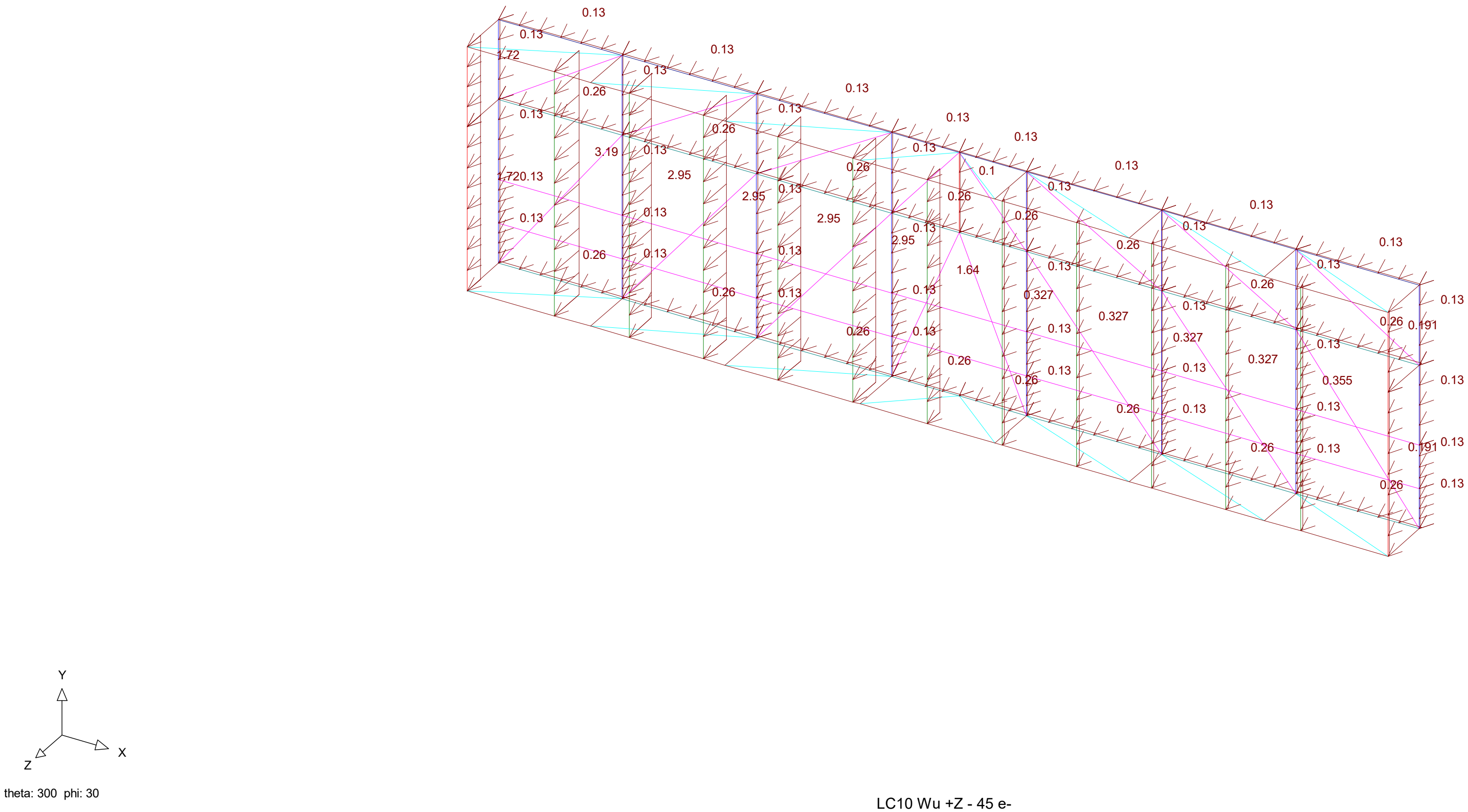




theta: 300 phi: 30

LC9 Wu +Z - 45 e+

Load Cases:
10 P Wu +Z - 45 e- (Ultimate Wind at +Z-dir)



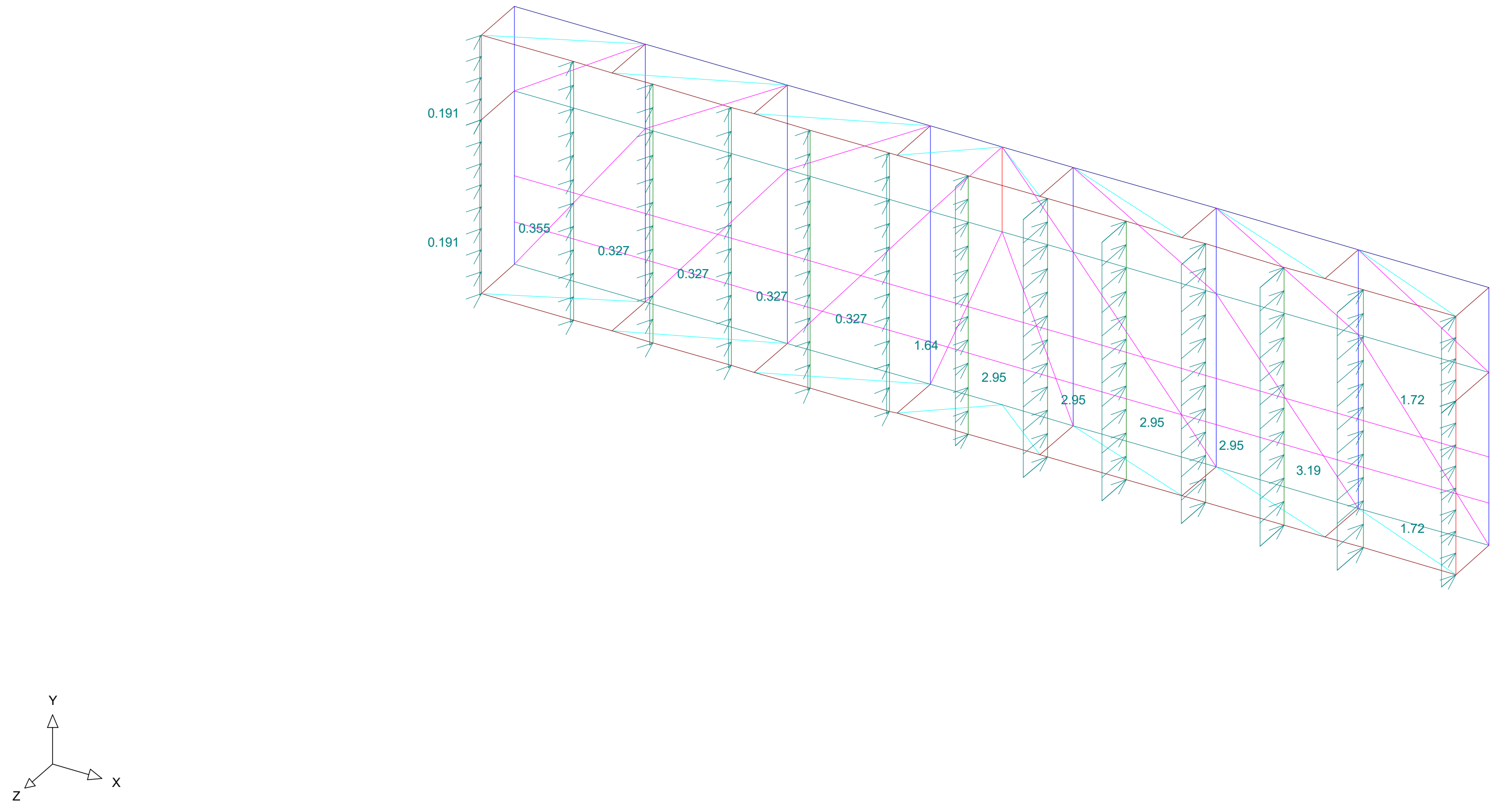
LC10 Wu +Z - 45 e-

Microstran V9

pilongoh5706
Job: Hunters Hill Bridge Signage c 08072019 (with supports)
Kingsford Smith Drive

13/08/2019
10:55:13 AM

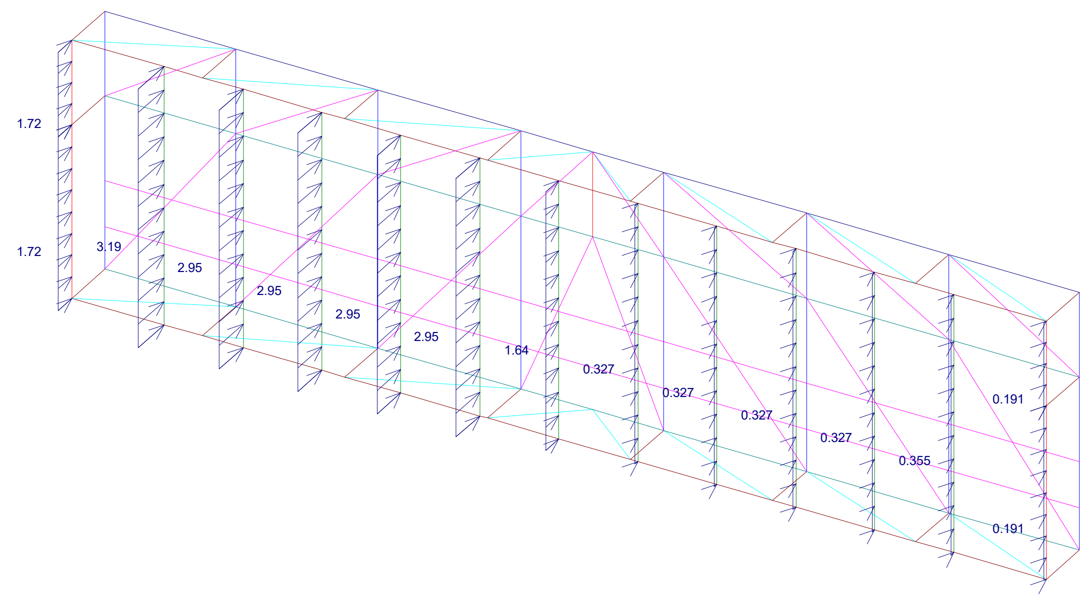
Load Cases:
11 P Wu -Z - 45 e+(Ultimate Wind at -Z-dir)

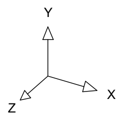


theta: 300 phi: 30

LC11 Wu -Z - 45 e+

Load Cases:
12 P Wu -Z - 45 e-(Ultimate Wind at -Z-dir)

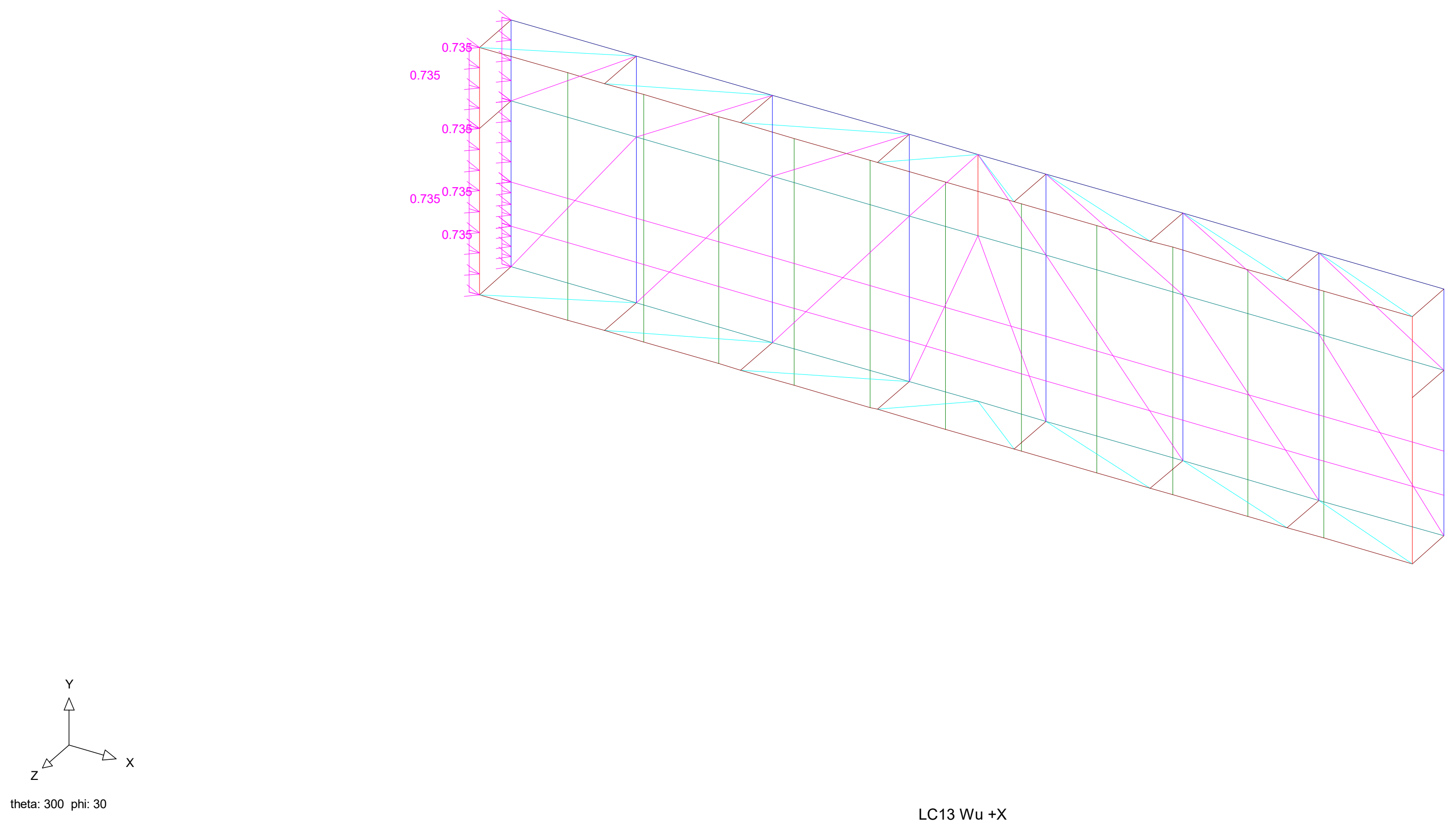




theta: 300 phi: 30

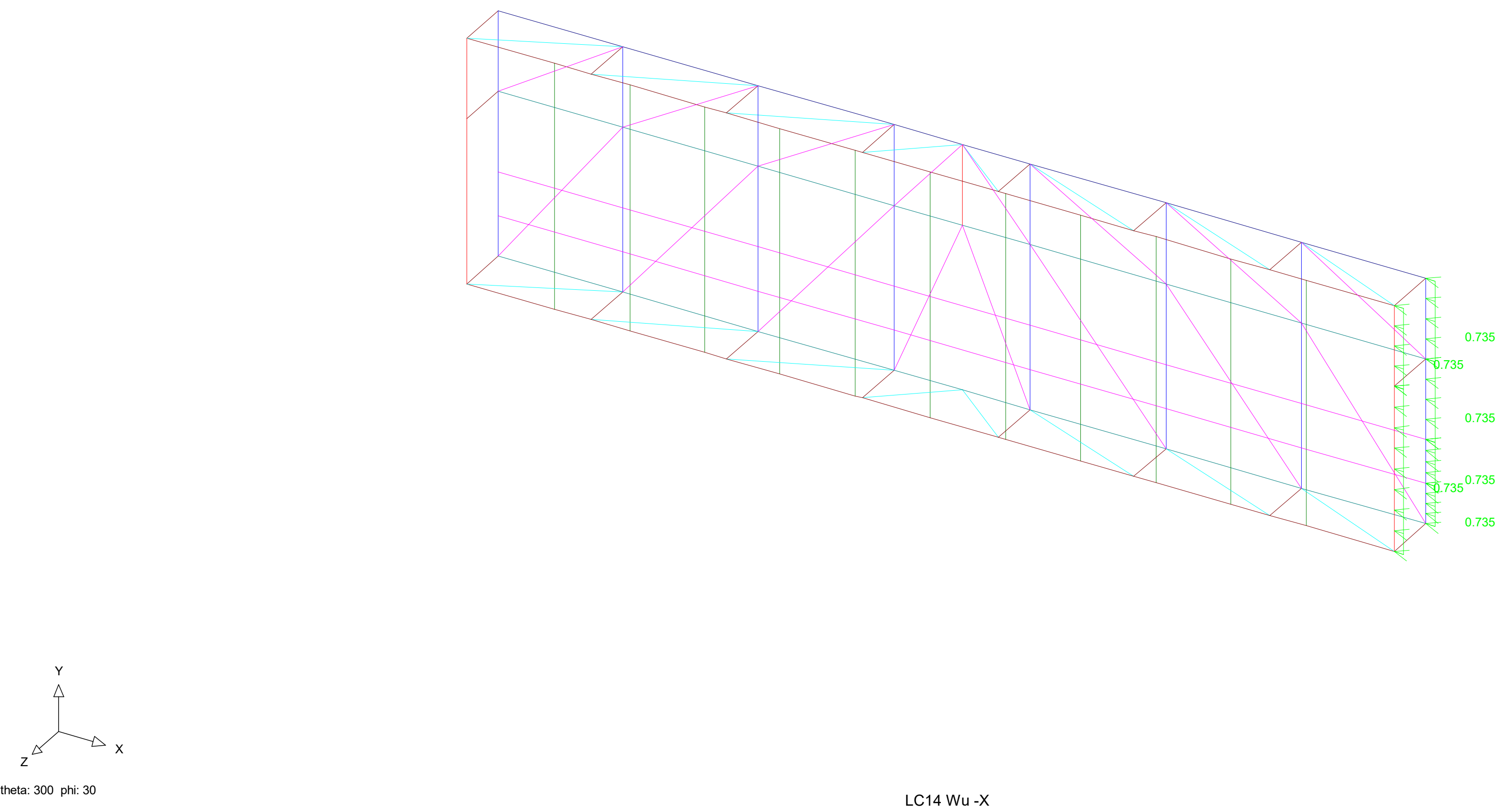
LC12 Wu -Z - 45 e-

Load Cases:
13 P Wu +X (Ultimate Wind at +X-dir)



LC13 Wu +X

Load Cases:
14 P Wu -X (Ultimate Wind at -X-dir)



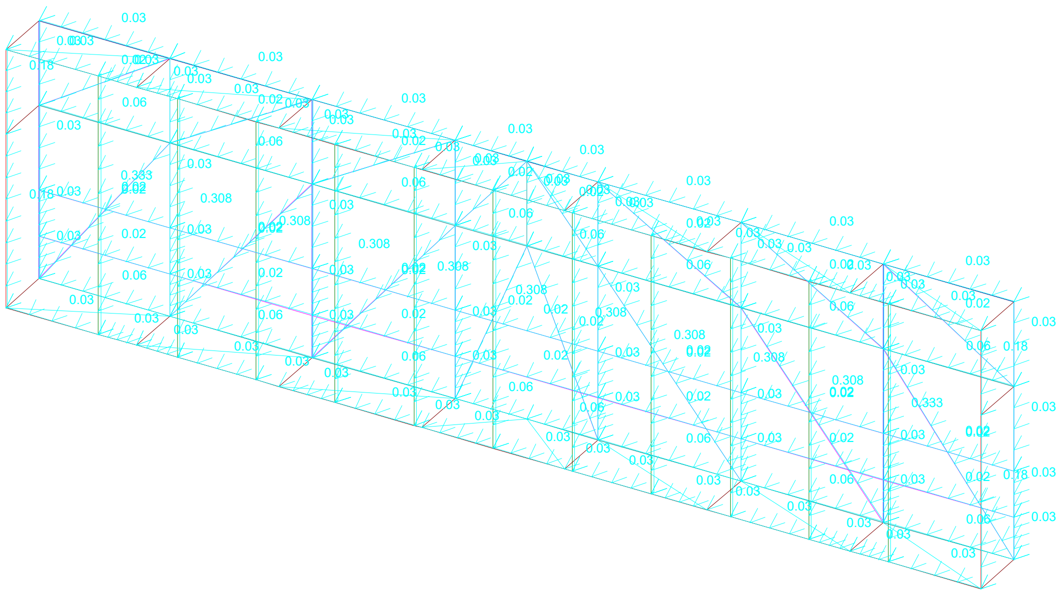
LC14 Wu -X

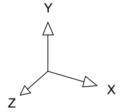
Microstran V9

pilongoh5706
Job: Hunters Hill Bridge Signage c 08072019 (with supports)
Kingsford Smith Drive

13/08/2019
10:58:18 AM

Load Cases:
60 P PNW (Natural Wind Gust Fatigue Load)





theta: 300 phi: 30

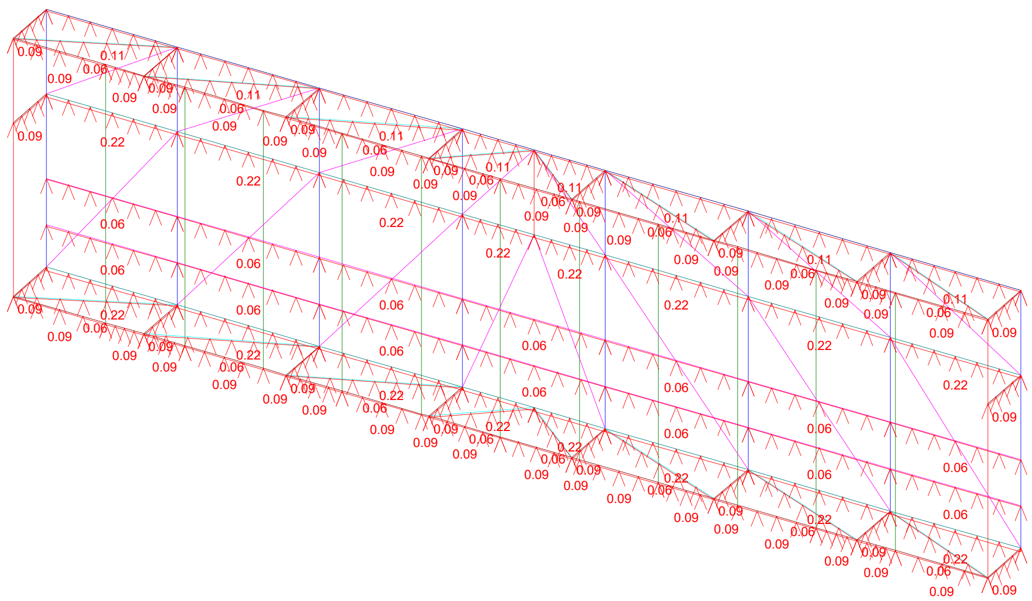
LC60 Natural Wind Gust Fatigue Load

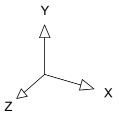
Microstran V9

pilongoh5706
Job: Hunters Hill Bridge Signage c 08072019 (with supports)
Kingsford Smith Drive

13/08/2019
10:58:56 AM

Load Cases:
61 P PTG (Truck-Induced Gust Fatigue Load)

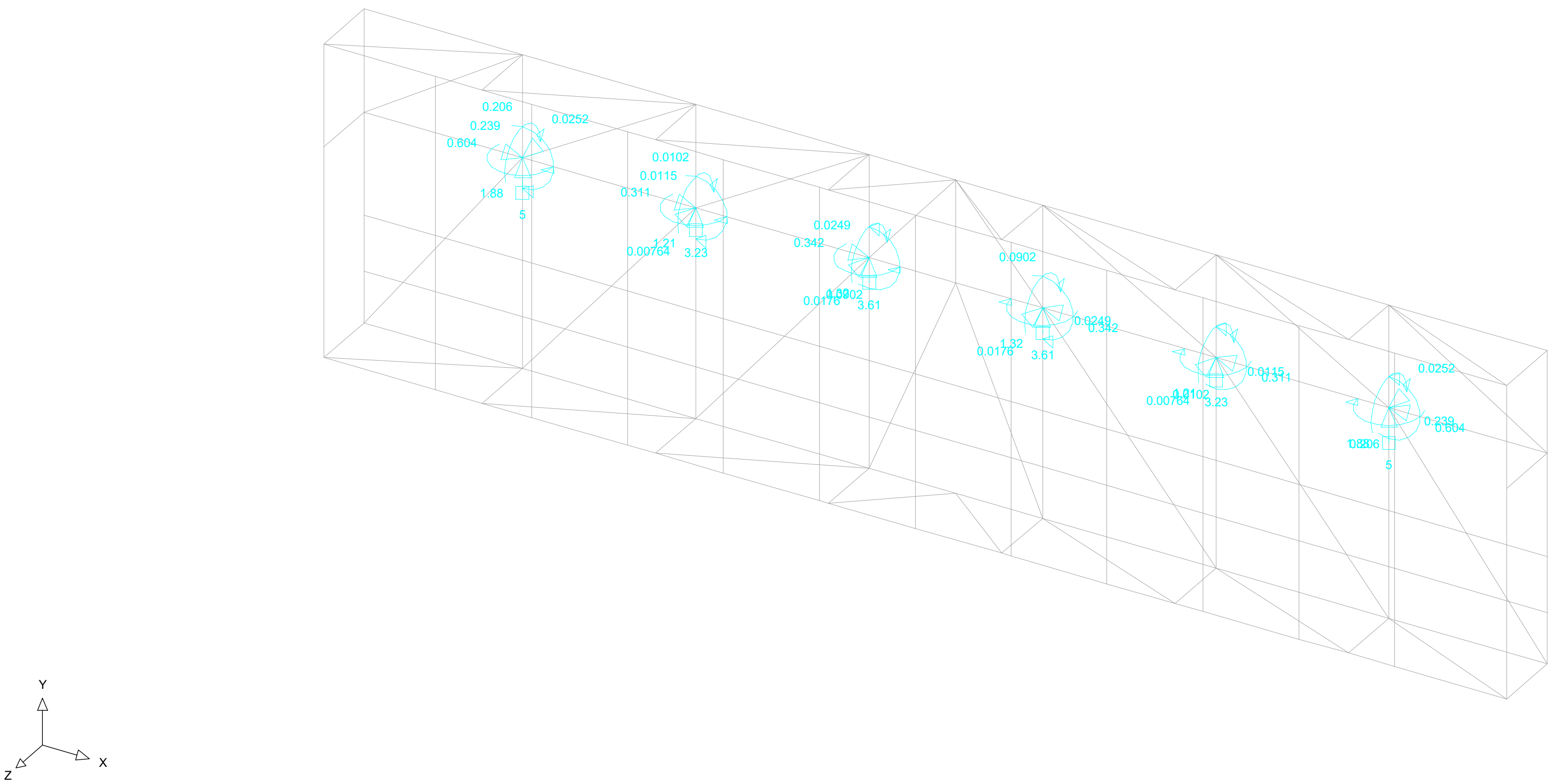




theta: 300 phi: 30

LC61 Truck-Induced Gust Fatigue Load

Load Cases:
3 P Q

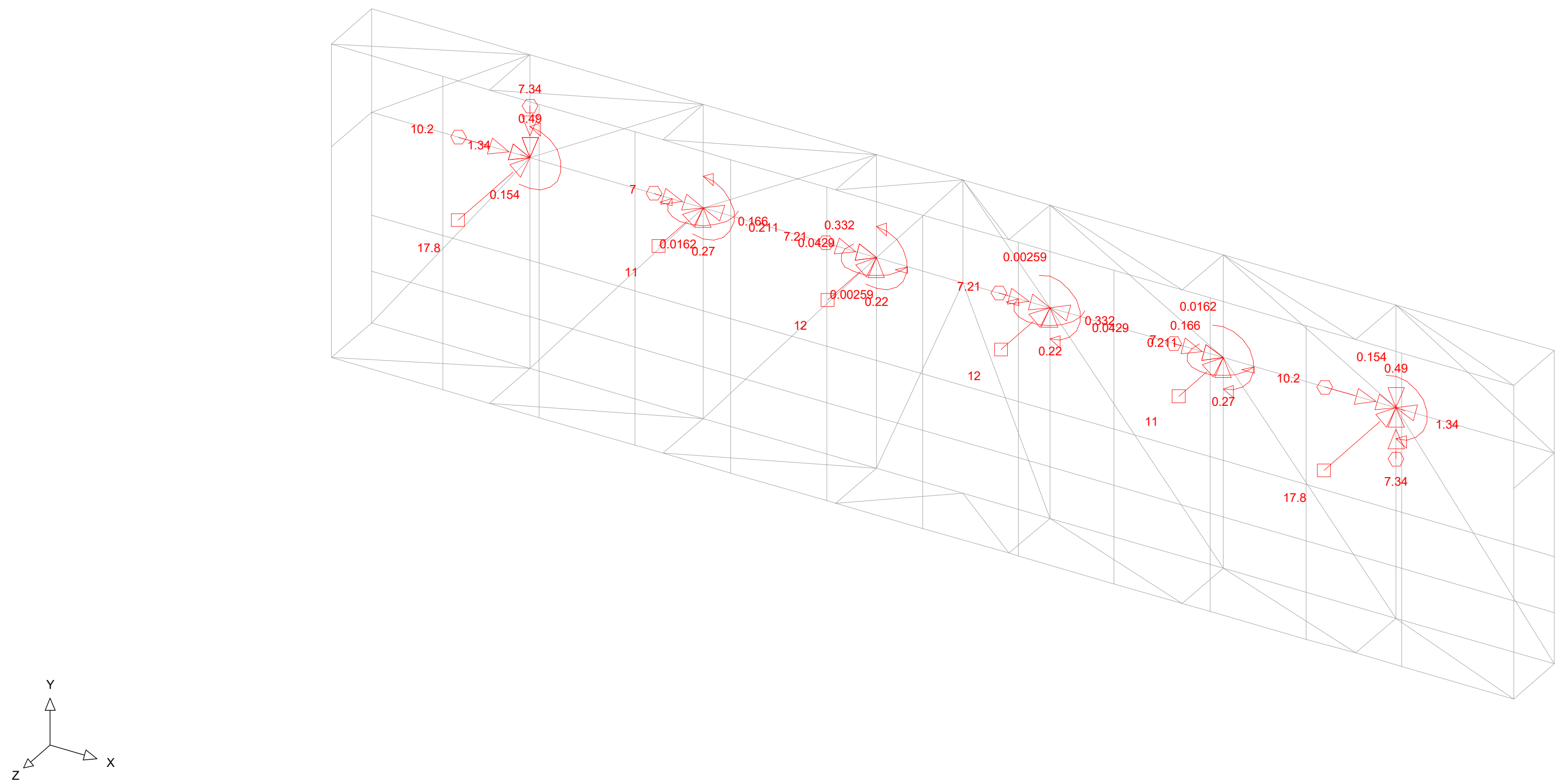


theta: 300 phi: 30

Support Reactions (LC3)

Support Reactions

Load Cases:
4 P Wu +Z

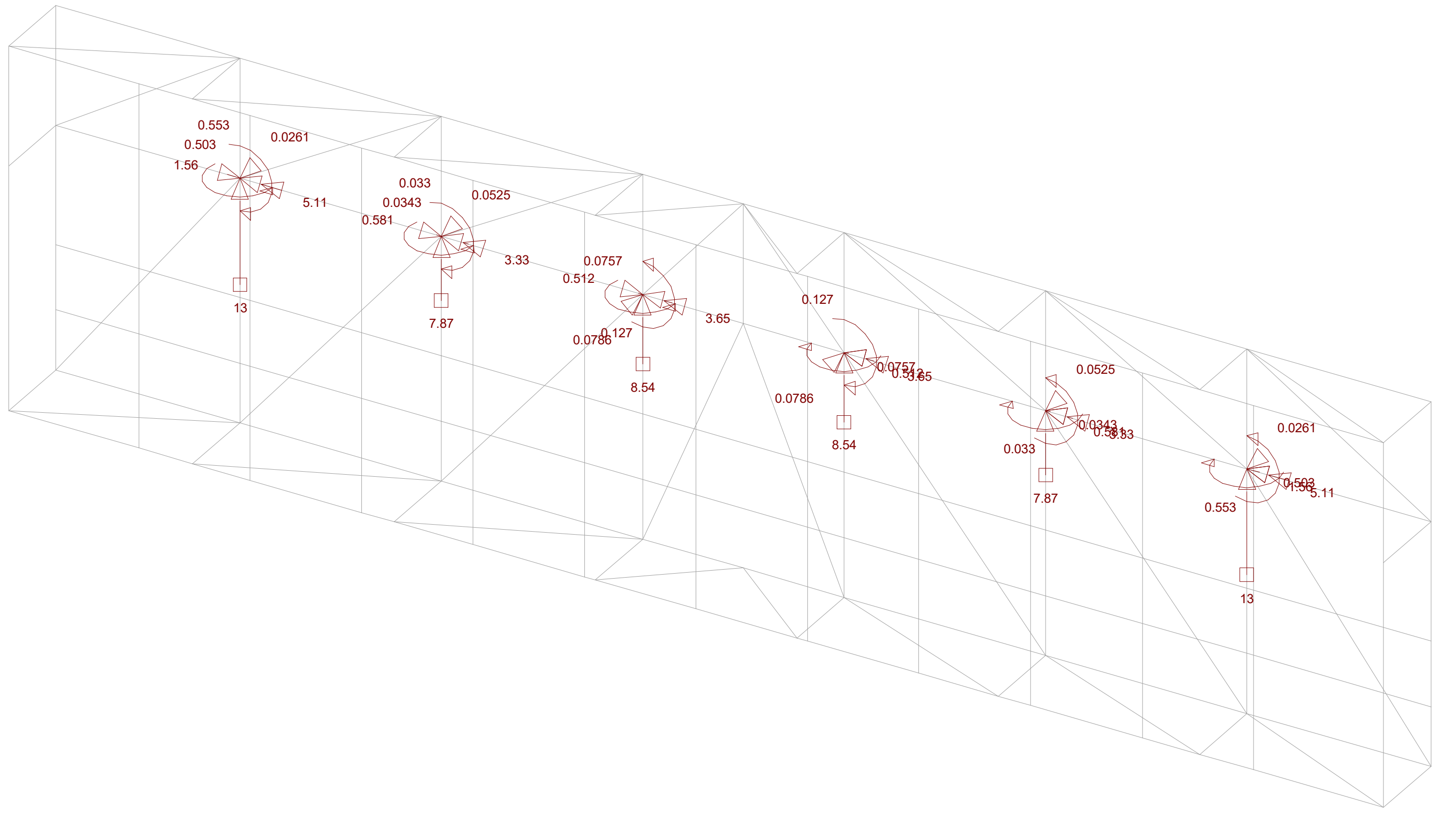


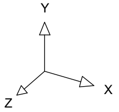
theta: 300 phi: 30

Support Reactions (LC4)

Support Reactions

Load Cases:
8 C G (SW + SDL)





theta: 300 phi: 30

Support Reactions (LC8)

Support Reactions

SUBJECT

H. Hunters Hill Bridge Reaction Forces

SUBJECT	CALCULATIONS	OUTPUT

Distance of Signboard (CG) to Girder (CG)	1.195	m
Distance of top Girder to Girder (CG)	0.6956	m
Length of signboard	12.63	m

Dead Load

Node	Case	FX	FY	FZ	MX	MY	MZ
44	8	1.555	13.046	0.026	-5.105	0.503	-0.553
45	8	0.581	7.874	0.052	-3.330	0.034	-0.033
46	8	0.512	8.541	-0.079	-3.653	0.076	0.127
47	8	-0.512	8.541	-0.079	-3.653	-0.076	-0.127
48	8	-0.581	7.874	0.052	-3.330	-0.034	0.033
49	8	-1.555	13.046	0.026	-5.105	-0.503	0.553
Sum		0.000	58.920	0.000	-24.175	0.000	0.000
Equivalent Line Load			4.665	kN/m			

Dead Load

Equivalent Line Load	4.665	kN/m
Moment due to dead load	5.575	KNm/m

Reaction forces from the signage are transferred to the center of gravity of the supporting girder hence inducing additional moment

Live Load

Node	Case	FX	FY	FZ	MX	MY	MZ
44	3	0.604	4.997	0.025	-1.882	0.239	-0.206
45	3	0.311	3.230	-0.008	-1.211	0.012	-0.010
46	3	0.342	3.613	-0.018	-1.321	0.025	0.090
47	3	-0.342	3.613	-0.018	-1.321	-0.025	-0.090
48	3	-0.311	3.230	-0.008	-1.211	-0.012	0.010
49	3	-0.604	4.997	0.025	-1.882	-0.239	0.206
Sum		0.000	23.682	0.000	-8.829	0.000	0.000
Equivalent Line Load			1.875	kN/m			

Live Load

Equivalent Line Load	1.875	kN/m
Moment due to dead load	2.241	KNm/m

SUBJECT

H. Hunters Hill Bridge Reaction Forces

SUBJECT	CALCULATIONS	OUTPUT

Distance of Signboard (CG) to Girder (CG)	1.195	m
Distance of top Girder to Girder (CG)	0.6956	m
Length of signboard	12.63	m

Wind Load

Node	Case	FX	FY	FZ	MX	MY	MZ
44	4	1.341	-0.490	-17.789	10.153	-7.340	0.154
45	4	-0.211	0.270	-10.953	7.002	-0.166	0.016
46	4	0.043	0.220	-11.995	7.208	0.332	0.003
47	4	-0.043	0.220	-11.995	7.208	-0.332	-0.003
48	4	0.211	0.270	-10.953	7.002	0.166	-0.016
49	4	-1.341	-0.490	-17.789	10.153	7.340	-0.154
Sum		0.000	0.000	-81.474	48.725	0.000	0.000
Equivalent Line Load			6.451	kN/m			

Wind Load

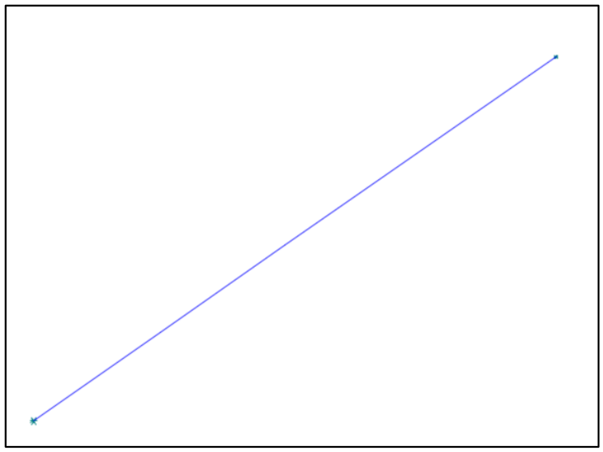
Equivalent Line Load	6.451	kN/m
Moment due to wind load	4.487	KNm/m

I. ETABS INPUT

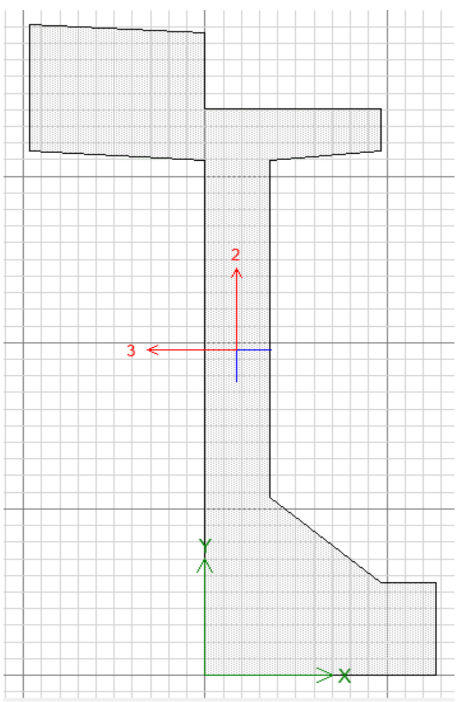
SUBJECT	CALCULATIONS	OUTPUT

I1. SECTION PROPERTY

Structural Geometry



Properties of Girder Section



Properties

Item	Value
Area, cm2	6954.8
AS2, cm2	3395.8
AS3, cm2	5398.8
I33, cm4	31406917.4
I22, cm4	4382399.9
S33Pos, cm3	321651.3
S33Neg, cm3	320684
S22Pos, cm3	77207.6
S22Neg, cm3	79681.8
R33, mm	672
R22, mm	251
Z33, cm3	432411.3
Z22, cm3	132081
J, cm4	1519084.5
CG Offset 3 Dir, mm	892.9
CG Offset 2 Dir, mm	1055.6
PNA Offset 3 Dir, mm	0
PNA Offset 2 Dir, mm	0

I.2 LOAD VALUES

Dead Load

Member	Unit weight	Area	Line Load	Lever Arm	Moment
	kN/m3	m2	kN/m	m	KNm/m
Girder	25.5	0.6958	17.74	-	-
Slab	25.5	0.1203	3.07	0.92	2.83
Hand Rail	-	-	1.00	0.33	0.33

Member	Unit weight	Area	Load	Lever Arm	Moment
	kN/m3	m2	kN	m	KNm/m
Post	77.0	0.0728	6.00	0.33	1.97

Member	Pressure	Width	Load	Lever Arm	Moment
	kPa	m	kN	m	KNm/m
Services	2.0	1.1176	2.24	-	-

Live Load

Member	Pressure	Width	Load	Lever Arm	Moment
	kPa	m	kN	m	KNm/m
Pedestrian	2.0	1.1176	2.24	-	-
Maintenance	2.0	1.1176	2.24	-	-

4 Loads

This chapter provides loading information as applied to the model.

4.1 Load Patterns

Table 4.1 - Load Patterns

Name	Type	Self Weight Multiplier	Auto Load
Dead	Dead	1	
LL (Maintenance)	Live	0	
LL (Pedestrian)	Live	0	
Wind	Wind	0	None
SDL (Slab)	Superimposed Dead	0	
SDL (Services)	Superimposed Dead	0	
SDL (Handrail + Post)	Superimposed Dead	0	
SDL (Signage)	Superimposed Dead	0	
LL (Gantry Signage)	Live	0	
Wind (Signage)	Wind	0	None

4.2 Applied Loads

4.2.1 Point Loads

Table 4.2 - Joint Loads - Force

Story	Label	Unique Name	Load Pattern	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	XDim mm	YDim mm
Base	1	1	SDL (Handrail + Post)	0	0	-6	1.965	0	0	0	0
Base	2	4	SDL (Handrail + Post)	0	0	-6	1.965	0	0	0	0
Base	5	2	SDL (Handrail + Post)	0	0	-6	1.965	0	0	0	0
Base	4	3	SDL (Handrail + Post)	0	0	-6	1.96	0	0	0	0

4.2.2 Line Loads

Table 4.3 - Frame Loads - Distributed (Part 1 of 2)

Story	Label	Unique Name	Design Type	Load Pattern	LoadType	Direction	Relative Distance Start	Relative Distance End	Absolute Distance Start mm
Base	B6	3	Beam	LL (Maintenance)	Force	Gravity	0	1	0
Base	B1	4	Beam	LL (Maintenance)	Force	Gravity	0	1	0
Base	B7	7	Beam	LL (Maintenance)	Force	Gravity	0	1	0
Base	B2	1	Beam	LL (Maintenance)	Force	Gravity	0	1	0
Base	B3	2	Beam	LL (Maintenance)	Force	Gravity	0	1	0
Base	B6	3	Beam	LL (Pedestrian)	Force	Gravity	0	1	0
Base	B1	4	Beam	LL (Pedestrian)	Force	Gravity	0	1	0
Base	B7	7	Beam	LL (Pedestrian)	Force	Gravity	0	1	0
Base	B2	1	Beam	LL (Pedestrian)	Force	Gravity	0	1	0
Base	B2	1	Beam	LL (Pedestrian)	Force	Gravity	1	1	8322
Base	B3	2	Beam	LL (Pedestrian)	Force	Gravity	0	0	0
Base	B3	2	Beam	LL (Pedestrian)	Force	Gravity	0	1	0
Base	B6	3	Beam	SDL (Slab)	Moment	Global-X	0	1	0
Base	B6	3	Beam	SDL (Slab)	Force	Gravity	0	1	0
Base	B1	4	Beam	SDL (Slab)	Moment	Global-X	0	1	0
Base	B1	4	Beam	SDL (Slab)	Force	Gravity	0	1	0

Table 4.3 - Frame Loads - Distributed (Part 1 of 2, continued)

Story	Label	Unique Name	Design Type	Load Pattern	LoadType	Direction	Relative Distance Start	Relative Distance End	Absolute Distance Start mm
Base	B7	7	Beam	SDL (Slab)	Moment	Global-X	0	1	0
Base	B7	7	Beam	SDL (Slab)	Force	Gravity	0	1	0
Base	B2	1	Beam	SDL (Slab)	Moment	Global-X	0	1	0
Base	B2	1	Beam	SDL (Slab)	Force	Gravity	0	1	0
Base	B3	2	Beam	SDL (Slab)	Moment	Global-X	0	1	0
Base	B3	2	Beam	SDL (Slab)	Force	Gravity	0	1	0
Base	B6	3	Beam	SDL (Services)	Force	Gravity	0	1	0
Base	B1	4	Beam	SDL (Services)	Force	Gravity	0	1	0
Base	B7	7	Beam	SDL (Services)	Force	Gravity	0	1	0
Base	B2	1	Beam	SDL (Services)	Force	Gravity	0	1	0
Base	B2	1	Beam	SDL (Services)	Force	Gravity	1	1	8322
Base	B3	2	Beam	SDL (Services)	Force	Gravity	0	0	0
Base	B3	2	Beam	SDL (Services)	Force	Gravity	0	1	0
Base	B6	3	Beam	SDL (Handrail + Post)	Moment	Global-X	0	1	0
Base	B6	3	Beam	SDL (Handrail + Post)	Force	Gravity	0	1	0
Base	B1	4	Beam	SDL (Handrail + Post)	Moment	Global-X	0	1	0
Base	B1	4	Beam	SDL (Handrail + Post)	Force	Gravity	0	1	0
Base	B7	7	Beam	SDL (Handrail + Post)	Moment	Global-X	0	1	0
Base	B7	7	Beam	SDL (Handrail + Post)	Force	Gravity	0	1	0
Base	B2	1	Beam	SDL (Handrail + Post)	Force	Gravity	0	1	0
Base	B2	1	Beam	SDL (Handrail + Post)	Moment	Global-X	0	1	0
Base	B2	1	Beam	SDL (Handrail + Post)	Moment	Global-X	1	1	8322
Base	B3	2	Beam	SDL (Handrail + Post)	Force	Gravity	0	1	0
Base	B3	2	Beam	SDL (Handrail + Post)	Moment	Global-X	0	0	0
Base	B3	2	Beam	SDL (Handrail + Post)	Moment	Global-X	0	1	0
Base	B2	1	Beam	SDL (Signage)	Force	Gravity	0	1	0
Base	B2	1	Beam	SDL (Signage)	Moment	Global-X	0	1	0
Base	B3	2	Beam	SDL (Signage)	Force	Gravity	0	1	0
Base	B3	2	Beam	SDL (Signage)	Moment	Global-X	0	1	0
Base	B2	1	Beam	LL (Gantry Signage)	Force	Gravity	0	1	0
Base	B2	1	Beam	LL (Gantry Signage)	Moment	Global-X	0	1	0
Base	B3	2	Beam	LL (Gantry Signage)	Force	Gravity	0	1	0
Base	B3	2	Beam	LL (Gantry Signage)	Moment	Global-X	0	1	0
Base	B6	3	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B6	3	Beam	Wind (Signage)	Moment	Global-X	0	1	0
Base	B1	4	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B1	4	Beam	Wind (Signage)	Moment	Global-X	0	1	0
Base	B7	7	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B7	7	Beam	Wind (Signage)	Moment	Global-X	0	1	0
Base	B2	1	Beam	Wind (Signage)	Moment	Global-X	0	1	0
Base	B2	1	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B2	1	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B2	1	Beam	Wind (Signage)	Moment	Global-X	0	1	0
Base	B3	2	Beam	Wind (Signage)	Moment	Global-X	0	1	0
Base	B3	2	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B3	2	Beam	Wind (Signage)	Force	Global-Y	0	1	0
Base	B3	2	Beam	Wind (Signage)	Moment	Global-X	0	1	0

Table 4.3 - Frame Loads - Distributed (Part 2 of 2)

Story	Label	Unique Name	Absolute Distance End mm	Force at Start kN/m	Force at End kN/m	Moment at Start kN-m/m	Moment at End kN-m/m
Base	B6	3	14834	2.24	2.24		
Base	B1	4	6560	2.24	2.24		
Base	B7	7	10541	2.24	2.24		
Base	B2	1	8322	2.24	2.24		
Base	B3	2	4308	2.24	2.24		
Base	B6	3	14834	2.24	2.24		
Base	B1	4	6560	2.24	2.24		
Base	B7	7	10541	2.24	2.24		
Base	B2	1	8322	2.24	2.24		
Base	B2	1	8322	2.24	2.24		
Base	B3	2	0	2.24	2.24		
Base	B3	2	4308	2.24	2.24		
Base	B6	3	14834			-2.83	-2.83
Base	B6	3	14834	3.07	3.07		
Base	B1	4	6560			-2.83	-2.83
Base	B1	4	6560	3.07	3.07		
Base	B7	7	10541			-2.83	-2.83
Base	B7	7	10541	3.07	3.07		
Base	B2	1	8322			-2.83	-2.83
Base	B2	1	8322	3.07	3.07		
Base	B3	2	4308			-2.83	-2.83
Base	B3	2	4308	3.07	3.07		
Base	B6	3	14834	2.24	2.24		
Base	B1	4	6560	2.24	2.24		
Base	B7	7	10541	2.24	2.24		
Base	B2	1	8322	2.24	2.24		
Base	B2	1	8322	2.24	2.24		
Base	B3	2	0	2.24	2.24		
Base	B3	2	4308	2.24	2.24		
Base	B6	3	14834			0.328	0.328
Base	B6	3	14834	1	1		
Base	B1	4	6560			0.328	0.328
Base	B1	4	6560	1	1		
Base	B7	7	10541			0.328	0.328
Base	B7	7	10541	1	1		
Base	B2	1	8322	1	1		
Base	B2	1	8322			0.328	0.328
Base	B2	1	8322			0.328	0.328
Base	B3	2	4308	1	1		
Base	B3	2	0			0.328	0.328
Base	B3	2	4308			0.328	0.328
Base	B2	1	8322	4.665	4.665		
Base	B2	1	8322			5.575	5.575
Base	B3	2	4308	4.665	4.665		
Base	B3	2	4308			5.575	5.575
Base	B2	1	8322	1.875	1.875		
Base	B2	1	8322			2.241	2.241

Table 4.3 - Frame Loads - Distributed (Part 2 of 2, continued)

Story	Label	Unique Name	Absolute Distance End mm	Force at Start kN/m	Force at End kN/m	Moment at Start kN-m/m	Moment at End kN-m/m
Base	B3	2	4308	1.875	1.875		
Base	B3	2	4308			2.241	2.241
Base	B6	3	14834	-0.45	-0.45		
Base	B6	3	14834			0.3	0.3
Base	B1	4	6560	-0.45	-0.45		
Base	B1	4	6560			0.3	0.3
Base	B7	7	10541	-0.45	-0.45		
Base	B7	7	10541			0.3	0.3
Base	B2	1	8322			4.487	4.487
Base	B2	1	8322	-6.451	-6.451		
Base	B2	1	8322	-0.45	-0.45		
Base	B2	1	8322			0.3	0.3
Base	B3	2	4308			4.487	4.487
Base	B3	2	4308	-6.451	-6.451		
Base	B3	2	4308	-0.45	-0.45		
Base	B3	2	4308			0.3	0.3

I.3 LOAD CASES AND COMBINATIONS

4.3 Load Cases

Table 4.4 - Load Cases - Summary

Name	Type
Dead	Linear Static
Live (M)	Linear Static
Live (P)	Linear Static
Wind	Linear Static
SDL (Slab)	Linear Static
SDL (Services)	Linear Static
SDL (Handrail + Post)	Linear Static
SDL (Signage)	Linear Static
LL (Gantry Signage)	Linear Static
SDL (Total)	Linear Static
Wind (Signage)	Linear Static

4.4 Load Combinations

Table 4.5 - Load Combinations

Name	Load Case/Combo	Scale Factor	Type	Auto
ULS1: 1.0G + 0.6Q(Pedestrian) + 1.0Wu	Dead	1	Linear Add	No
ULS1: 1.0G + 0.6Q(Pedestrian) + 1.0Wu	Live (P)	0.6		No
ULS1: 1.0G + 0.6Q(Pedestrian) + 1.0Wu	Wind	1		No
ULS1: 1.0G + 0.6Q(Pedestrian) + 1.0Wu	SDL (Total)	1		No
ULS2: 1.2SW + 1.4SDL + 1.5LL(Maintenance)	Dead	1.2	Linear Add	No
ULS2: 1.2SW + 1.4SDL + 1.5LL(Maintenance)	SDL (Total)	1.4		No
ULS2: 1.2SW + 1.4SDL + 1.5LL(Maintenance)	Live (M)	1.5		No
ULS3: 1.2SW + 1.4SDL + 1.5LL(Gantry)	Dead	1.2	Linear Add	No
ULS3: 1.2SW + 1.4SDL + 1.5LL(Gantry)	SDL (Total)	1.4		No
ULS3: 1.2SW + 1.4SDL + 1.5LL(Gantry)	LL (Gantry Signage)	1.5		No

Table 4.5 - Load Combinations (continued)

Name	Load Case/Combo	Scale Factor	Type	Auto
ULS4: 1.0G + 1.0Wu	Dead	1	Linear Add	No
ULS4: 1.0G + 1.0Wu	SDL (Total)	1		No
ULS4: 1.0G + 1.0Wu	Wind (Signage)	1		No
Envelope	ULS1: 1.0G + 0.6Q(Pedestrian) + 1.0Wu	1	Envelope	No
Envelope	ULS2: 1.2SW + 1.4SDL + 1.5LL(Maintenance)	1		No
Envelope	ULS3: 1.2SW + 1.4SDL + 1.5LL(Gantry)	1		No
Envelope	ULS4: 1.0G + 1.0Wu	1		No
ULS5: 1.0G + 1.0Wu (-)	Dead	1	Linear Add	No
ULS5: 1.0G + 1.0Wu (-)	SDL (Total)	1		No
ULS5: 1.0G + 1.0Wu (-)	Wind (Signage)	-1		No
ULS6: 1.0G + 0.6Q(Pedestrian) + 1.0Wu (-)	Dead	1	Linear Add	No
ULS6: 1.0G + 0.6Q(Pedestrian) + 1.0Wu (-)	Live (P)	0.6		No
ULS6: 1.0G + 0.6Q(Pedestrian) + 1.0Wu (-)	Wind	-1		No
ULS6: 1.0G + 0.6Q(Pedestrian) + 1.0Wu (-)	SDL (Total)	1		No

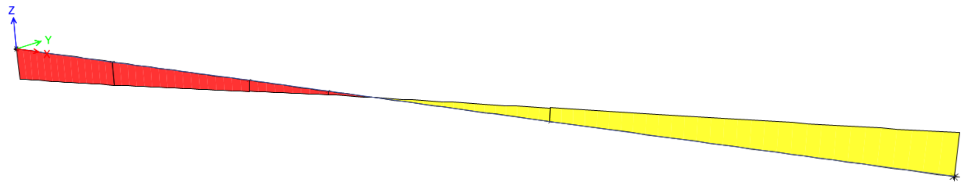
J. ETABS OUTPUT

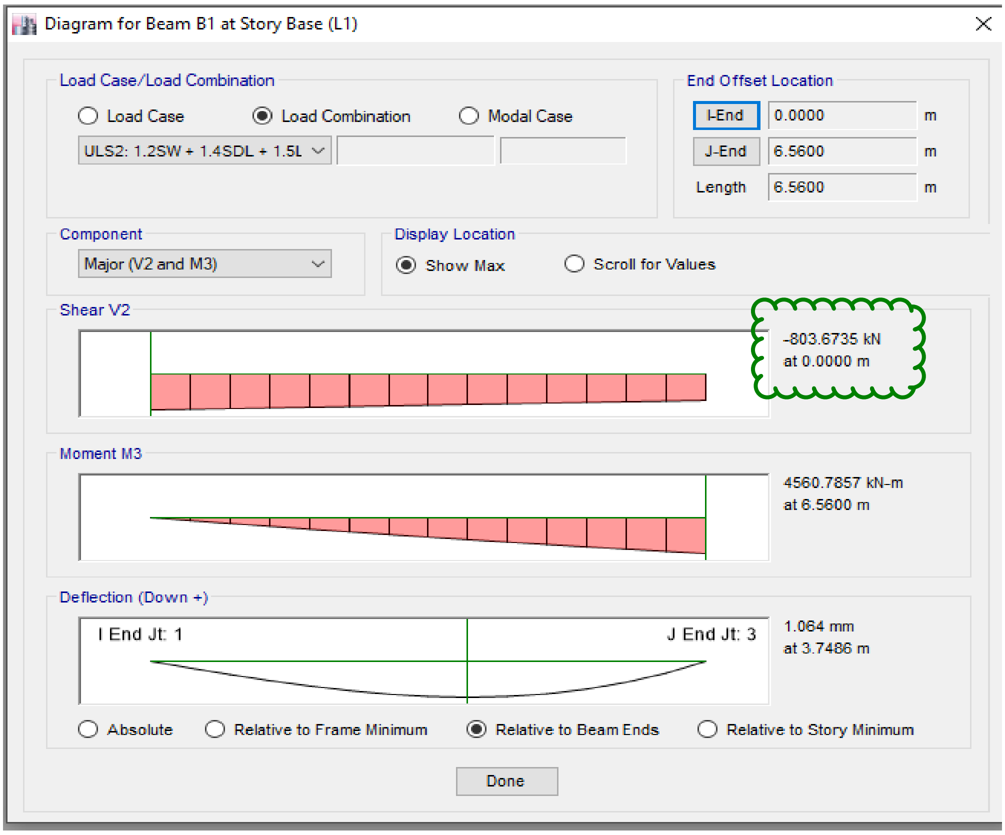
Summary of Member Forces **(Taken from ETABS)**

Member	Case	P	V2	V3	T	M2	M3
		kN	kN	kN	kNm	kNm	kNm
B1	ULS 2	0.0	-803.7	0.0	-5.2	0.0	0.0
B1	ULS5	0.0	-575.9	-68.0	-50.7	0.0	0.0
B2	ULS 4	0.0	-420.5	65.0	57.7	-436.2	3268.2
B3	ULS 4	0.0	-151.3	1.0	-17.2	-742.3	5943.0
B7	ULS2	0.0	0.8	0.0	-30.9	0.0	8871.3

Maximum	Value	Unit
P	0.0	kN
V2	-803.7	kN
V3	-68.0	kN
T	57.7	kNm
M2	-742.3	kNm
M3	8871.3	kNm

Member Forces **(Shear Major Axis)**

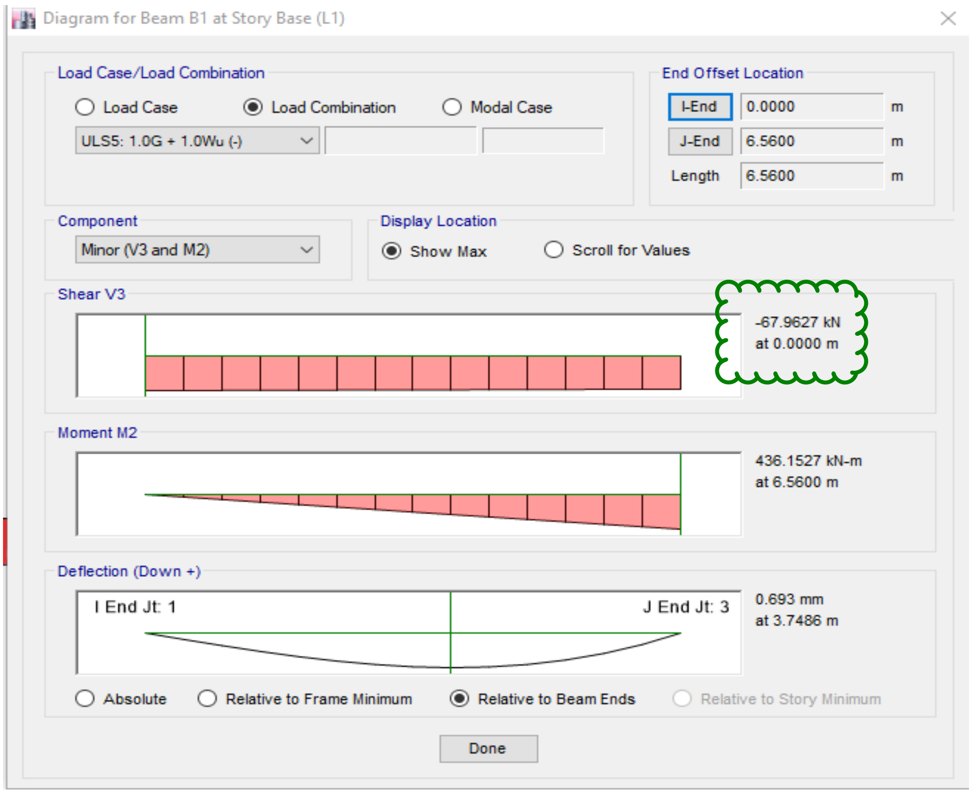




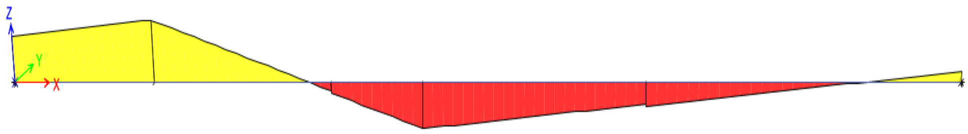
ARCADIS	DOCUMENT No	SHEET
SUBJECT	**Hunters Hill Bridge**	

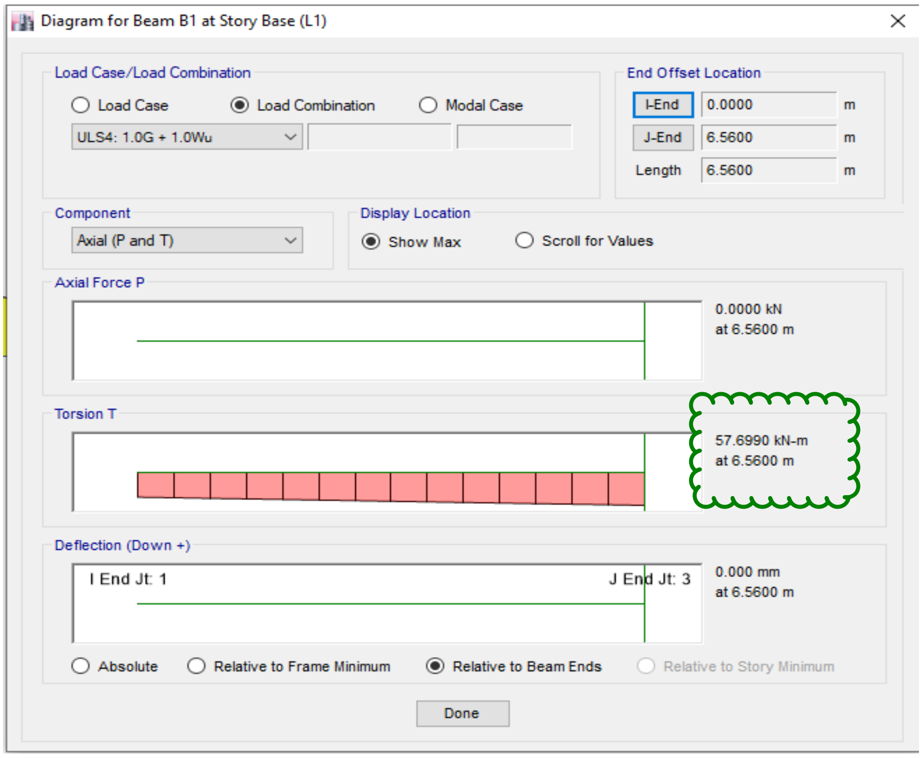
SUBJECT	CALCULATIONS	OUTPUT

Member Forces **(Shear Minor Axis)**



Member Forces (Torsion)

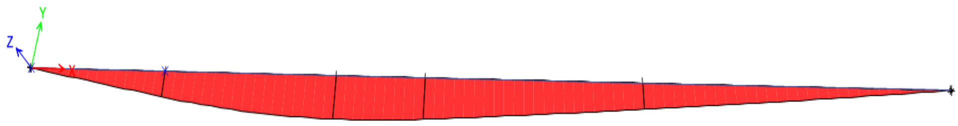


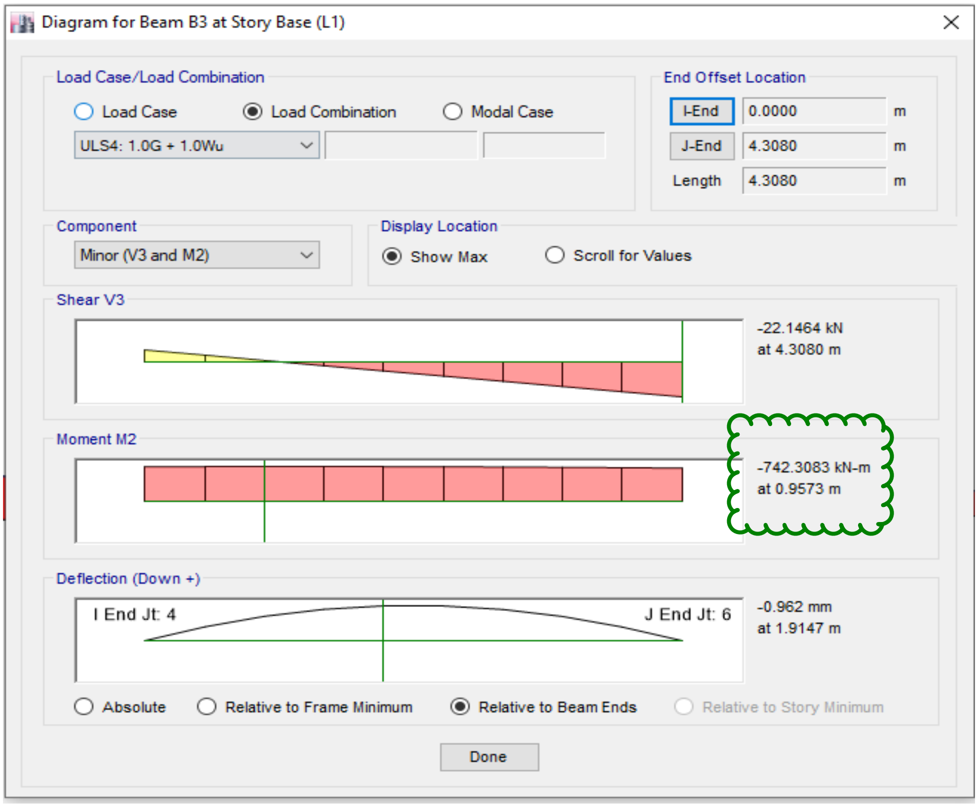


ARCADIS	DOCUMENT No	SHEET
SUBJECT	Hunters Hill Bridge	

SUBJECT	CALCULATIONS	OUTPUT

Member Forces **(Moment-minor axis)**

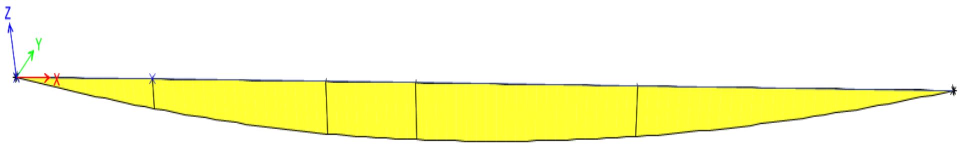


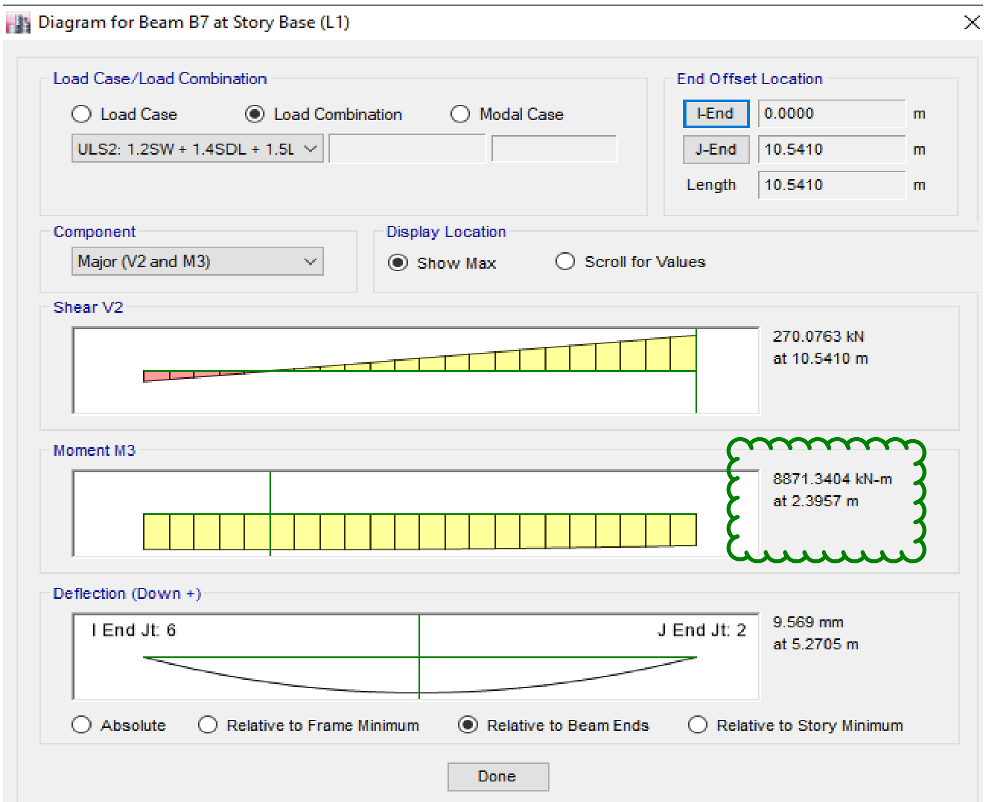


ARCADIS	DOCUMENT No	SHEET
SUBJECT	Hunters Hill Bridge	

SUBJECT	CALCULATIONS	OUTPUT

Member Forces (Moment-major axis)





ARCADIS	DOCUMENT No	SHEET

SUBJECT

K. SHEAR AND TORSION CHECKS (Major axis)

REFERENCE	CALCULATIONS	OUTPUT

Design Parameters

Shear Force, V*	=	803.7	kN	Φ	=	0.7	(Shear)
Torsion Force, T*	=	58	kNm	Φ	=	0.7	(Torsion)
Moment, M*	=	8871.3	kNm				
PT Force, Pv	=	5760	kN				
Axial Force, N*	=	0	kN				

Capacity Reduction Factors

Section Properties

Shape	=	Irregular	(input rectangular or irregular)
Beam width, bv	=	180	mm
Beam depth, h	=	1930.4	mm
Concrete cover, cc	=	25	mm

Material Properties

Concrete elastic modulus, Ec	=	40000	MPa
Steel elastic modulus, Es	=	200000	MPa
Pre steel elastic modulus, Ep	=	200000	MPa
Concrete strength,f'c	=	50	MPa
Shear strength, fy	=	400	MPa
Prestress yield strength	=	0	MPa

Other Parameters

Links

Number of Legs	=	2	
Diameter, d	=	10	mm
Provided spacing, s	=	300	mm
Effective depth, de	=	1889.4	mm

Reinforcements

Number of Layers = 0

Layers

	Diameter	Number	Area	
Layer 1	12	0.001	0.1131	mm^2
Layer 2	0	0	0	mm^2
Layer 3			0	mm^2
Layer 4			0	mm^2
Reinforcement	5434.1131			

Area of shear reinforcement, Asv	=	157	mm^2
Asv/s	=	0.52	mm^2/mm
Asw/s	=	0.26	mm^2/mm
Area of pre steel used	=	9120.73	mm^2

Equivalent factored shear force

Eq. 8.2.1.2(4)

(a) *For solid sections:*

$$V^*_{eq} = \sqrt{(V^*)^2 + \left[\frac{0.9T^*u_h}{2A_o}\right]^2}$$

Veq* **970.83515** kN

Critical Torsion

Eq. 8.2.1.2(2)

$$T_{cr} = 0.33\sqrt{f'_c}\frac{A_{cp}^2}{p_c}\sqrt{\left(1+\frac{\sigma_{cp}}{0.33\sqrt{f'_c}}\right)}$$

		For rectangular		For irregular	
Area of outside perimeter, Acp	=	347472	mm^2	695400	mm^2
Outside perimeter of concrete, pc	=	4220.8	mm	6500	mm
Average prestress intensity, σcp	=	0		0	

	Tcr	=	**Not Applicable** kNm	**173.6020935** kNm

Checking

a. V* > 0.5Φ(Vuc + Pv)

803.7 < 2055.3 **No need to provide shear reinforcement**

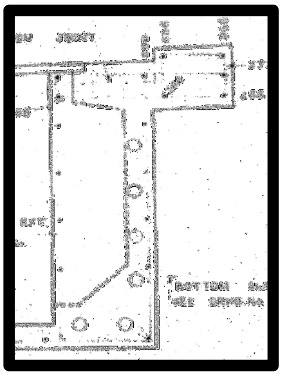
b. T* >0.25ΦTcr

58 > 30.38 **Provide torsional reinforcement**

c. D > 750

1930.4 > 750 **Provide shear reinforcement**

Reinforcement Checks



Ao considered

Torsion Design

Required Torsional Reinforcement

$$\frac{Asw}{s} = \frac{T^*/\Phi}{2Ao\ fsy.f\ \cot\theta v} = 0.12997775$$

Spacing = 604.255849 *USE* ***600*** mm

Torsional Reinforcement Spacing

smax = 0.12ut or 300 mm (min)

0.12ut = 467.136 or 300 mm

USE ***300*** mm

Spacing required = 300 mm

Spacing used = 300 mm **Spacing is adequate against torsion**

Minimum transverse shear reinforcement

$$\frac{0.06\ \sqrt{f'c}\ bv}{fsy.f} = 0.19091883$$

$$\frac{0.35\ bv}{fsy.f} = 0.1575$$

Remarks **adequate reinforcement**

Shear Design

Concrete Shear Strength

Method Used: General

Vuc = 112.246512 kNm

θv = 41.1111225 degrees

General Method

Cl. 8.2.4.1 * Vuc = kv √(f'c) bv dv = 112.246512 kN

Effective Shear depth = 1744 mm

Cl. 8.2.4.6 kv = 0.0505672

$$k_v = \left[\frac{0.4}{(1+1500\varepsilon_x)}\right]\left[\frac{1300}{1000+k_{dg}d_v}\right]$$

where

$$k_{dg} = \frac{32}{(16+d_g)} \text{ but not less than 0.80}$$

d_g = maximum nominal aggregate size

kdg 1.0667

dg 14

max aggregate size

SHEAR AND TORSION CHECKS

REFERENCE	CALCULATIONS	OUTPUT

Eq.8.2.4.4(3)

Moment

M* ≥ 8695.81151 kNm
M* = 8871.3 kNm

V^* and M^* are absolute values and

$$M^* \geq d_v \sqrt{(V^* - P_v)^2 + \left[\frac{0.9T^* p_h}{2A_o}\right]^2}$$

Cl. 8.2.4.4

ex for combined shear and torsion

$$\varepsilon_x = \frac{M^*/d_v + \sqrt{(V^* - P_v)^2 + \left[\frac{0.9T^* u_h}{2A_o}\right]^2} + 0.5N^* - A_{pt} f_{po}}{2(E_s A_{st} + E_p A_{pt})}$$

$$\varepsilon_x \geq 0$$

$$\varepsilon_x \leq +3.0 \times 10^{-3}$$

$$\varepsilon_x = \frac{M^*/d_v + \sqrt{(V^* - P_v)^2 + \left[\frac{0.9T^* u_h}{2A_o}\right]^2} + 0.5N^* - A_{pt} f_{po}}{2(E_s A_{st} + E_p A_{pt} + E_c A_{ct})}$$

$$\varepsilon_x \geq -0.2 \times 10^{-3}$$

$$\varepsilon_x \leq 0$$

εx = **0.00173016**

Cl. 8.2.4.2

θv = **41.1111225** Prestressed

$$\theta_v = (29 + 7000\varepsilon_x) \quad \geq 30° \text{ for reinforced concrete members}$$
$$\geq 20° \text{ for prestressed concrete members}$$

Cl. 8.2.3.1

Required Shear Reinforcement

Vus req = Veq/Φ - (Vuc +Pv) = -4485.3392 kN

Additional shear reinforcement is not required

Cl. 8.2.5.2

$$\frac{Asv}{s} = \frac{Vus}{fsy.f\ do\ \cot\theta v} = \text{N/A}$$

S = N/A USE **N/A** mm

Cl. 8.3.2.2

Shear Reinforcement Spacing

smax = 0.5D or 300 mm (minimum)

0.5D = 965.2 mm
USE **300** mm

Required Spacing = 300 mm
Actual Spacing = 300 mm **Spacing is adequate against shear**

SHEAR AND TORSION CHECKS (Minor axis)

REFERENCE	CALCULATIONS	OUTPUT

Design Parameters

Shear Force, V*	=	68	kN
Torsion Force, T*	=	52	kNm
Moment, M*	=	742	kNm
PT Force, Pv	=	0	kN
Axial Force, N*	=	0	kN

Capacity Reduction Factors

Φ	=	0.7	(Shear)
Φ	=	0.7	(Torsion)

Section Properties

Shape	=	Irregular	(input rectangular or irregular)
Beam width, bv	=	1930.4	mm
Beam depth, h	=	180	mm
Concrete cover, cc	=	25	mm

Material Properties

Concrete elastic modulus, Ec	=	40000	MPa
Steel elastic modulus, Es	=	200000	MPa
Pre steel elastic modulus, Ep	=	200000	MPa
Concrete strength,f'c	=	50	MPa
Shear strength, fy	=	400	MPa
Prestress yield strength	=	0	MPa

Other Parameters

Links

Number of Legs	=	2	
Diameter, d	=	10	mm
Provided spacing, s	=	300	mm
Effective depth, de	=	139	mm

Reinforcements

Number of Layers	=	0	

Layers

	Diameter	Number	Area	
Layer 1	12	0.001	0.1131	mm^2
Layer 2	0	0	0	mm^2
Layer 3			0	mm^2
Layer 4			0	mm^2
Reinforcement	5434.1131			

Area of shear reinforcement, Asv	=	157	mm^2
Asv/s	=	0.52	mm^2/mm
Asw/s	=	0.26	mm^2/mm
Area of pre steel used	=	9120.73	mm^2

Equivalent factored shear force

Eq. 8.2.1.2(4)

(a) *For solid sections:*

$$V^*_{eq} = \sqrt{(V^*)^2 + \left[\frac{0.9T^* u_h}{2A_o}\right]^2}$$

Veq* **492.972891** kN

Critical Torsion

Eq. 8.2.1.2(2)

$$T_{cr} = 0.33\sqrt{f'_c}\frac{A^2_{cp}}{p_c}\sqrt{\left(1+\frac{\sigma_{cp}}{0.33\sqrt{f'_c}}\right)}$$

		For rectangular		For irregular	
Area of outside perimeter, Acp	=	347472	mm^2	695400	mm^2
Outside perimeter of concrete, pc	=	4220.8	mm	6500	mm
Average prestress intensity, σcp	=	0		0	

Tcr = **Not Applicable** kNm **173.6020935** kNm

SHEAR AND TORSION CHECKS

REFERENCE	CALCULATIONS	OUTPUT

Checking

a. V* > 0.5Φ(Vuc + Pv)

68 < 1207.9 **No need to provide shear reinforcement**

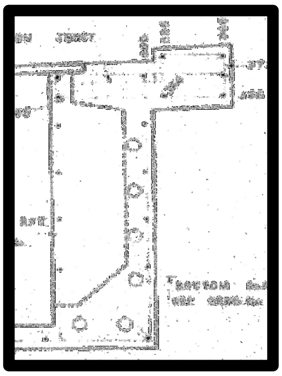
b. T* >0.25ΦTcr

52 > 30.38 **Provide torsional reinforcement**

c. D > 750

180 < 750 **No need to provide shear reinforcement**

Reinforcement Checks



Ao considered

Torsion Design

Required Torsional Reinforcement

$$\frac{Asw}{s} = \frac{T^*/\Phi}{2Ao\ fsy.f\ \cot\theta v} = 0.07767125$$

Spacing = 1011.18262 *USE* ***1000*** mm

Torsional Reinforcement Spacing

smax = 0.12ut or 300 mm (min)

0.12ut = 467.136 or 300 mm

USE ***300*** mm

Spacing required = 300 mm

Spacing used = 300 mm **Spacing is adequate against torsion**

Minimum transverse shear reinforcement

$\frac{0.06\ \sqrt{(f'c)}\ bv}{fsy.f}$ = 2.0474984

$\frac{0.35\ bv}{fsy.f}$ = 1.6891

Remarks **adequate reinforcement**

Shear Design

Concrete Shear Strength

Method Used: General

Vuc = 3451.19384 kNm

θv = 30.1854509 degrees

General Method

Cl. 8.2.4.1 * Vuc = kv √(f'c) bv dv = 3451.19384 kN

Effective Shear depth = 1744 mm

Cl. 8.2.4.6 kv = 0.14497415

$$k_v = \left[\frac{0.4}{(1+1500\varepsilon_x)}\right]\left[\frac{1300}{1000+k_{dg}d_v}\right]$$

where

$$k_{dg} = \frac{32}{(16+d_g)}$$ but not less than 0.80

d_g = maximum nominal aggregate size

kdg 1.0667

dg 14

max aggregate size

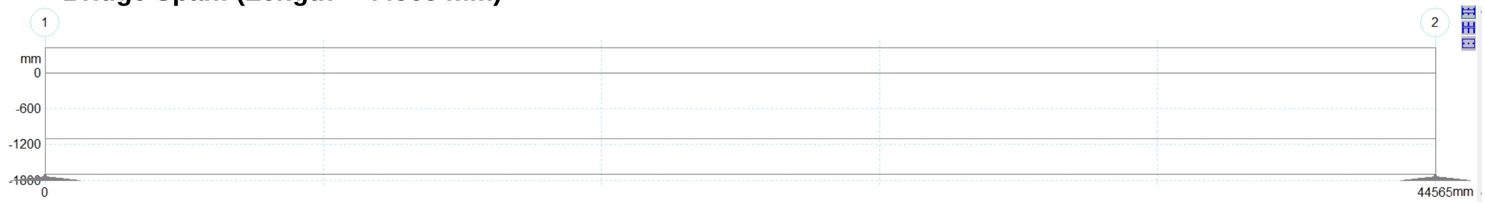
SHEAR AND TORSION CHECKS

REFERENCE	CALCULATIONS	OUTPUT
Eq.8.2.4.4(3)	**Moment** M* ≥ 859.744721 kNm M* = 859.744721 kNm V^* and M^* are absolute values and $M^* \geq d_v \sqrt{\left(V^* - P_v\right)^2 + \left[\frac{0.9T^* p_h}{2A_o}\right]^2}$	
Cl. 8.2.4.4	**ex for combined shear and torsion** $\varepsilon_x = \frac{M^*/d_v + \sqrt{\left(V^* - P_v\right)^2 + \left[\frac{0.9T^* u_h}{2A_o}\right]^2} + 0.5N^* - A_{pt} f_{po}}{2\left(E_s A_{st} + E_p A_{pt}\right)}$ $\varepsilon_x \geq 0$ $\varepsilon_x \leq +3.0 \times 10^{-3}$ $\varepsilon_x = \frac{M^*/d_v + \sqrt{\left(V^* - P_v\right)^2 + \left[\frac{0.9T^* u_h}{2A_o}\right]^2} + 0.5N^* - A_{pt} f_{po}}{2\left(E_s A_{st} + E_p A_{pt} + E_c A_{ct}\right)}$ $\varepsilon_x \geq -0.2 \times 10^{-3}$ $\varepsilon_x \leq 0$ εx = **0.00016935**	
Cl. 8.2.4.2	θv = **30.1854509** Prestressed $\theta_v = (29 + 7000\varepsilon_x)$ ≥ 30° for reinforced concrete members ≥ 20° for prestressed concrete members	
Cl. 8.2.3.1	**Required Shear Reinforcement** Vus req = Veq/Φ - (Vuc +Pv) = -2746.9469 kN	**Additional shear reinforcement is not required**
Cl. 8.2.5.2	$\frac{Asv}{s} = \frac{Vus}{fsy.f\ do\ \cot\theta v}$ = N/A S = N/A USE **N/A** mm	

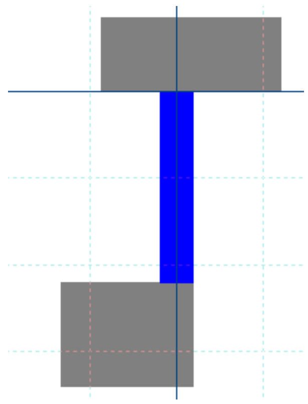
L. POST-TENSION REINFORCEMENT CHECK

RAPT inputs:

Bridge Span: (Length = 44565 mm)

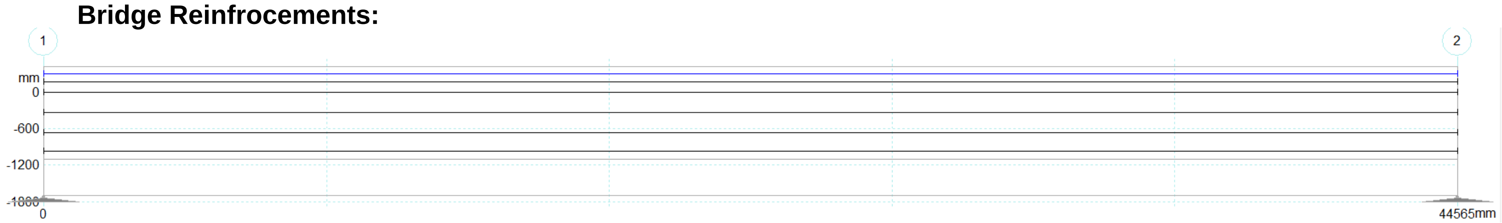


Girder Section used:



Layer Number	Aa	mm	mm	mm	mm	mm
2	Upturn Layer	-427	430	600	430	600
3	Slab Panel	0	95	95	95	95
4	Effective Beam Flange	1100	95	95	95	95
5	Downturn Layer	1700	660	95	660	95

Bridge Reinfrocements:



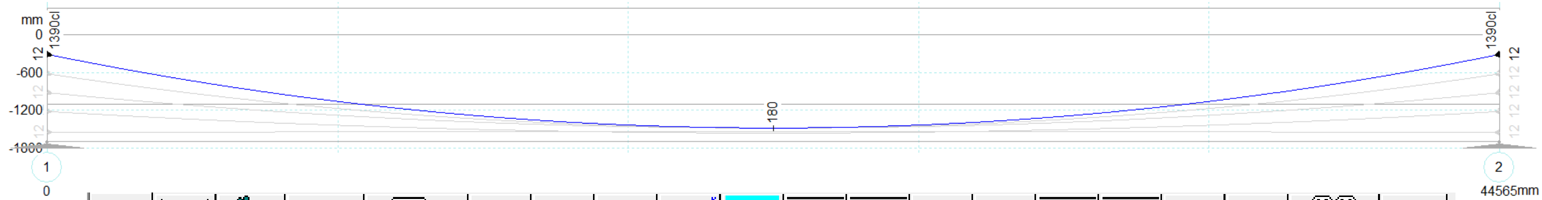
Top Bars:

Column Strip		#	mm	mm	mm	%	%	#	mm	mm	mm	%	%		#	mm	%	y/n
1	N 500M	1	0	0	120	100	100	2	0	0	120	100	100	10	6	0	0	×
2	N 500MPa	1	0	0	250	100	100	2	0	0	250	100	100	10	3	0	0	×

General Bars:

Column Strip		#	mm	mm	mm	%	%	#	mm	mm	mm	%	%		#	mm	%	y/n
1	N 500M	1	0	0	420	100	100	2	0	0	420	100	100	10	2	0	0	×
2	N 500MPa	1	0	0	750	100	100	2	0	0	750	100	100	10	2	0	0	×
3	N 500MPa	1	0	0	1090	100	100	2	0	0	1090	100	100	10	2	0	0	×
4	N 500MPa	1	0	0	1390	100	100	2	0	0	1390	100	100	10	2	0	0	×

Bridge Prestressing: (Assumed Prestressing Force = 124.38 kN)



							#.#	mm	mm	#	mm		y/n	#	mm		y/n		mm
1		Strand	12.7mm	MultiStrand	12	12	1	40	40	1	-0			3	0			Individual	44565
2		Strand	12.7mm	MultiStrand	12	12	1	40	40	1	-0			3	0			Individual	44565
3		Strand	12.7mm	MultiStrand	12	12	1	40	40	1	-0			3	0			Individual	44565
4		Strand	12.7mm	MultiStrand	12	12	1	40	40	1	-0			3	0			Individual	44565
5		Strand	12.7mm	MultiStrand	12	12	1	40	40	1	-0			3	0			Individual	44565
6		Strand	12.7mm	MultiStrand	12	12	1	40	40	1	-0			3	0			Individual	44565

RAPT inputs:

LOADINGS:

Girder Self-weight:

Load Case	Load Type	Load Definition	Live Load Deflection Case	Description
			y/n	Aa
1	Self Weight	Applied Loads		
2	Extra Dead Load	Applied Loads		
3	Live Load	Applied Loads	✓	

	#	mm	kN/m	#	mm	kN/m	Aa
1	1	-0	17.4	2	0	17.4	

Live Load (Bridge Maintenance):

Load Case	Load Type	Load Definition	Live Load Deflection Case	Description
1	Self Weight	Applied Loads		
2	Extra Dead Load	Applied Loads		
3	Live Load	Applied Loads	✓	

	#	mm	kN/m	#	mm	kN/m	#.#	Aa
1	1	-0	2.24	2	0	2.24	1	Maintenance

Initial Dead Load (Loads already applied on the girder):

Load Case	Load Type	Load Definition	Live Load Deflection Case	Description
			y/n	Aa
1	Self Weight	Applied Loads		
2	Initial Dead Load	Applied Loads		
3	Extra Dead Load	Applied Loads		
4	Live Load	Applied Loads	✓	

	#	mm	kN/m	#	mm	kN/m	Aa
1	1	-0	3.07	2	0	3.07	slab
2	1	-0	2.24	2	0	2.24	services
3	1	-0	1	2	0	1	handrail

Load Case	Load Type	Load Definition	Live Load Deflection Case	Description
1	Self Weight	Applied Loads		
2	Initial Dead Loa	Applied Loads		
3	Live Load	Applied Loads	✓	

	#	mm	kN	mm	Aa
1	1	14933.3	6	0	post
2	1	0	6	0	post
3	1	29866.7	6	0	post
4	2	0	6	0	post

Extra Dead Load (Additional Load due to the signage):

Load Case	Load Type	Load Definition	Live Load Deflection Case	Description
			y/n	Aa
1	Self Weight	Applied Loads		
2	Initial Dead Load	Applied Loads		
3	Extra Dead Load	Applied Loads		
4	Live Load	Applied Loads	✓	

	#	mm	kN/m	#	mm	kN/m	Aa
1	1	6560	4.7	1	19190	4.7	

Live Load (Signage Maintenance):

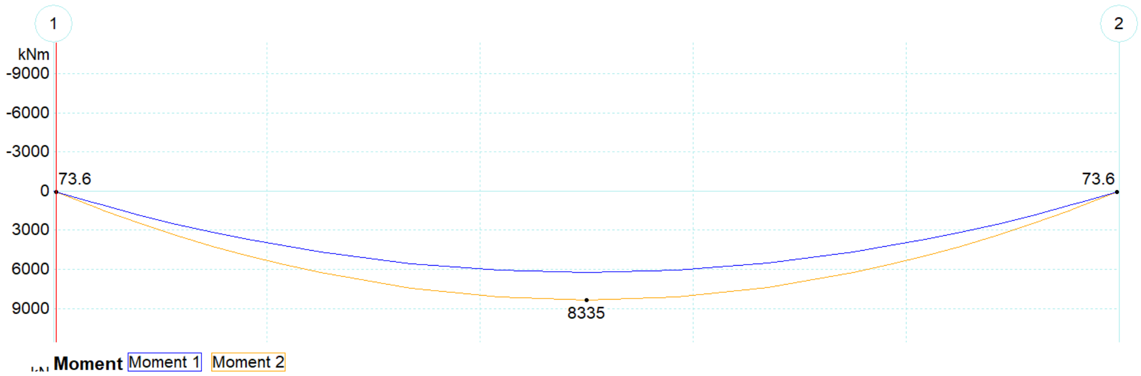
Load Case	Load Type	Load Definition	Live Load Deflection Case	Description
			y/n	Aa
1	Self Weight	Applied Loads		
2	Initial Dead Load	Applied Loads		
3	Extra Dead Load	Applied Loads		
4	Live Load	Applied Loads	✓	

	#	mm	kN/m	#	mm	kN/m	#.#	Aa
1	1	6560	1.88	1	19190	1.88	1	LL Gantry

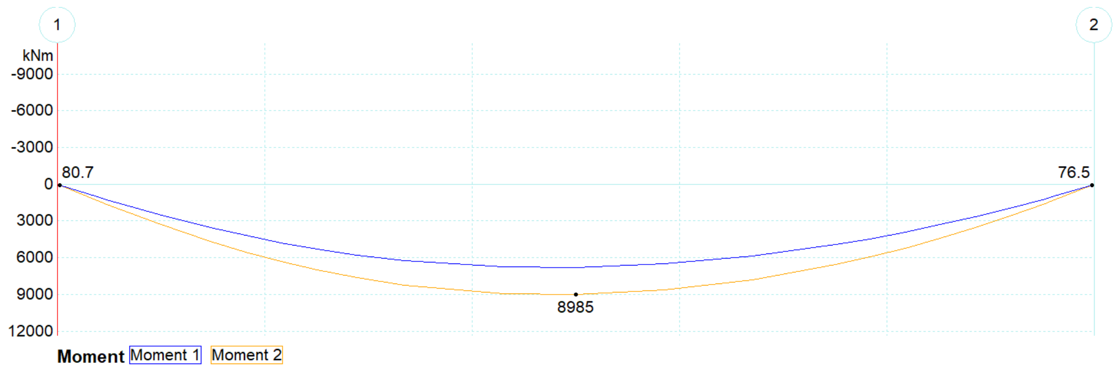
RAPT results:

Ultimate Flexure:

Ultimate Moment (without signange load) - without considering prestress

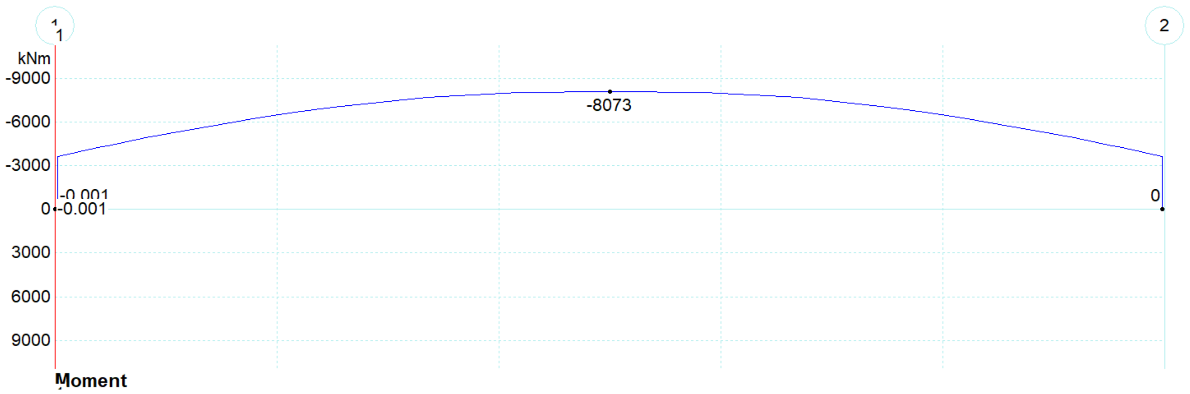


Ultimate Moment (with signange load) - without considering prestress

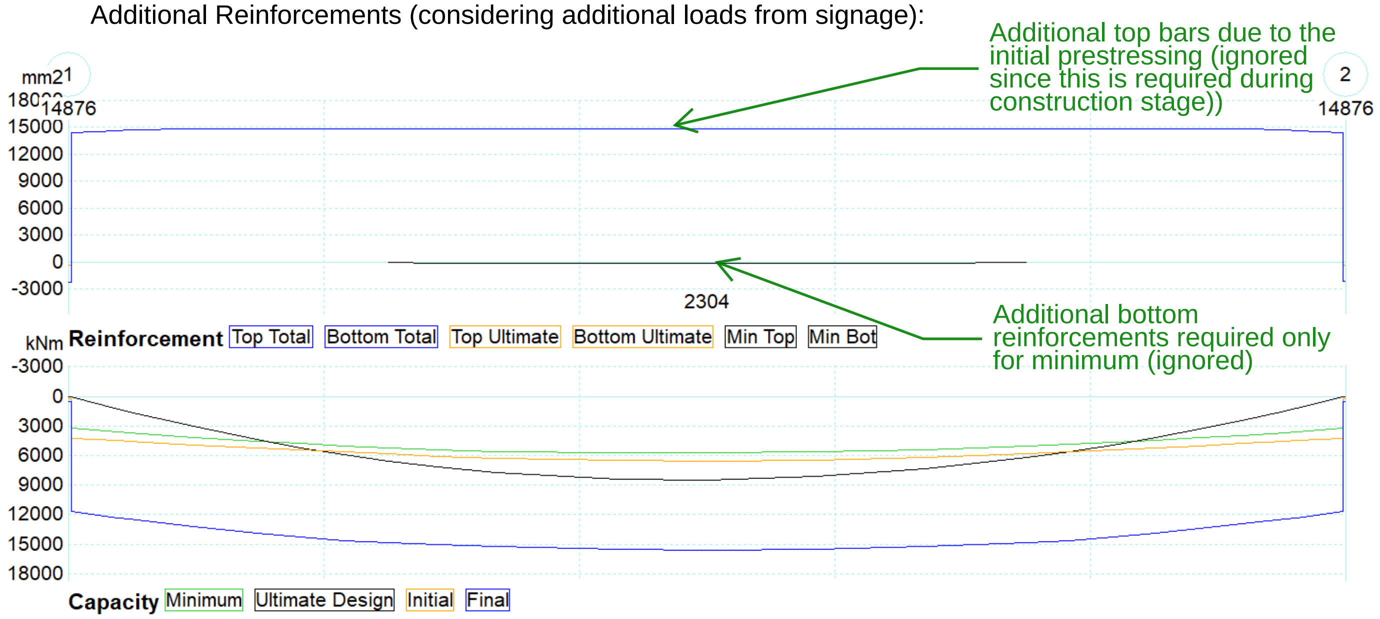


Additional moment = 8985 - 8335 = 650 kNm

Prestress Transfer



Additional Reinforcements (considering additional loads from signage):

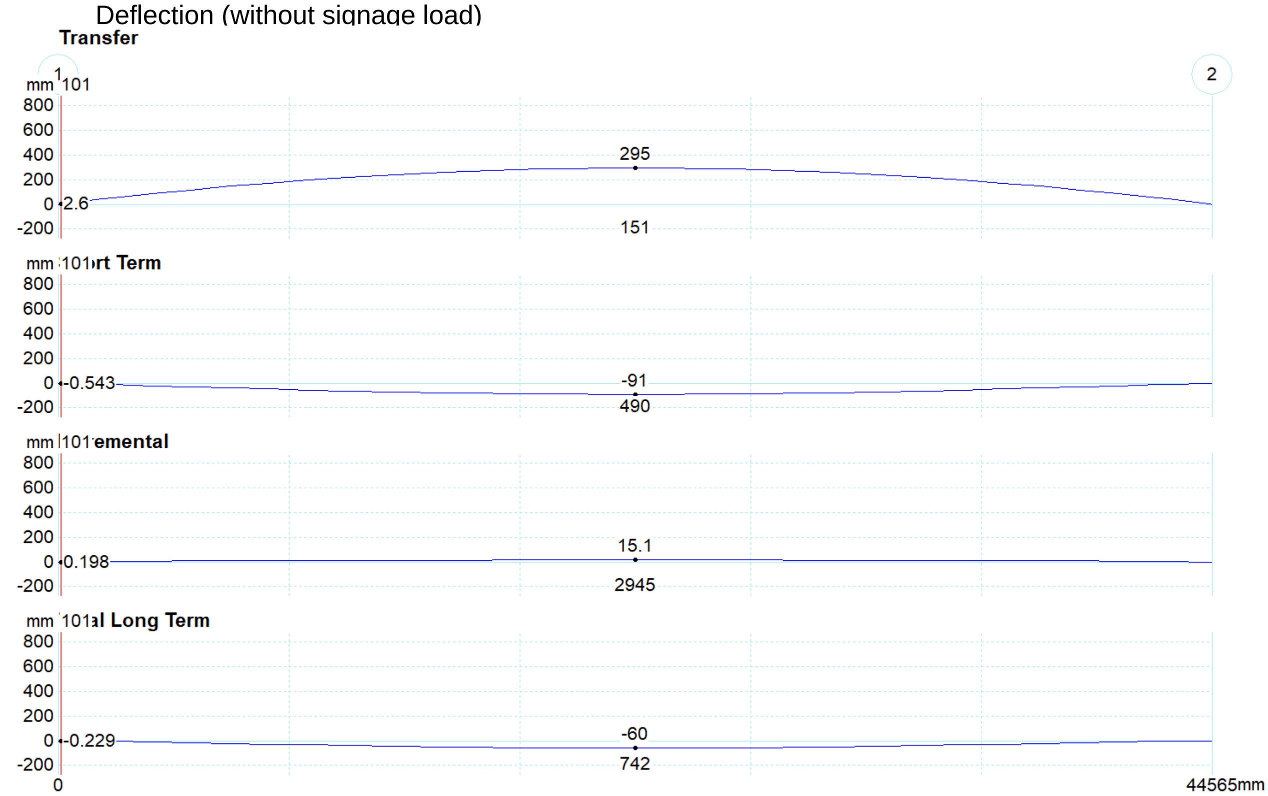


Note: Additional top bars to be ignored since these are required bars during construction (prestressing). Since this bridge assessment doesn't consider this load case, top bar requirements can be ignored.

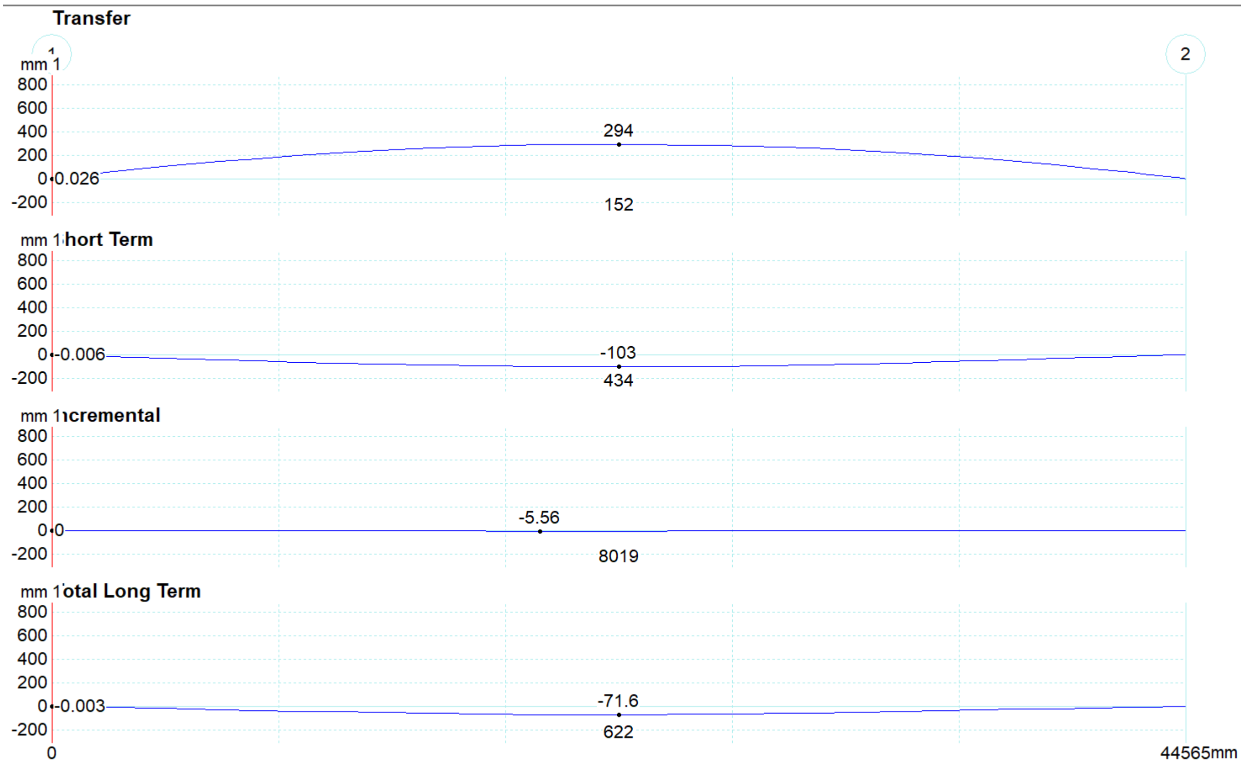
RAPT results:

Deflection:

Deflection (without signage load)



Deflection (with signage load)



Additional Deflection = 71.6 - 60 = 11.6 mm

Deflection Correction:

From RAPT, Moment of Inertia obtained (idealized section) = 2.58e11

From ETABS, Moment of Inertia obtained (actual) = 3.14e11

Maximum deflection (including signage loads) = 71.6(I_{RAPT}/I_{ETABS})

Maximum deflection (including signage loads) = 58.83 mm

Allowable deflection = L/600 = 74.275 mm

Maximum deflection (58.83 mm) < Allowable deflection (74.275 mm), OK

M. Stability Check (Sliding and Overturning)

REFERENCE	CALCULATIONS	OUTPUT

Bridge inputs

Web width, W1A	0.18	m
(Bridge Length)/2, (L1)/2	22.50	m
Diaphragm width, W1B	0.18	m
Bridge width, W2	22.00	m
Depth, H1	1.90	m
Concrete unit weight	25.50	kN/m^3
# of webs	11.00	pcs
# of diaphragms	7.00	pcs
Volume of opening (600mm dia.)	0.41	m^3
Bottom Slab thickness	0.12	m
Top slab thickness	0.20	m

Signage inputs

Signage Length, L2	12.63	m
Signage Height, H2	3.35	m

Calculated self weight of signage (from Microstran)

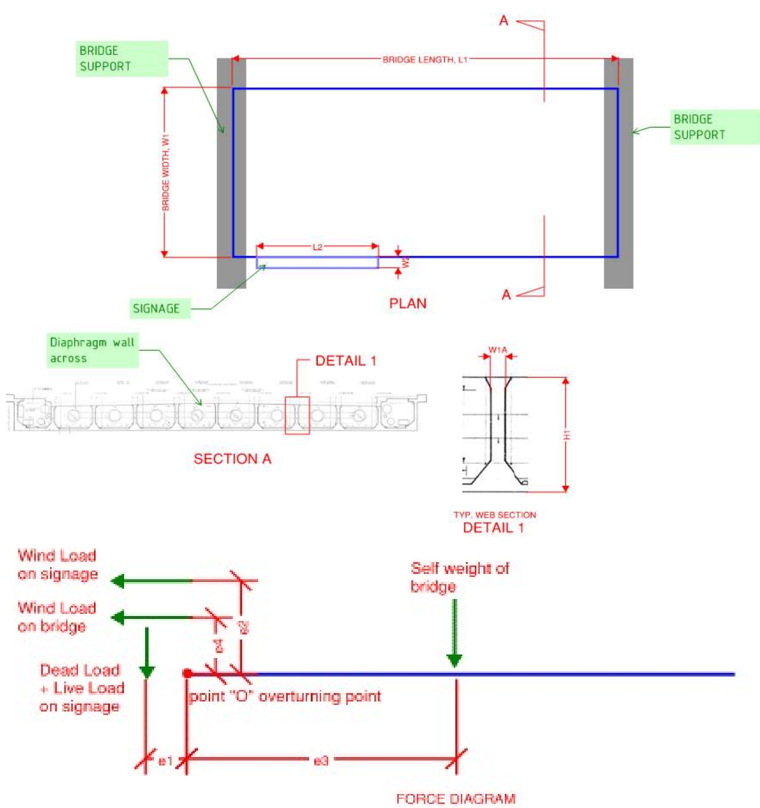
Signage Dead Load	4.67	kN/m

Wind Load on Signage

Calculated wind pressure	1.60	kN/m

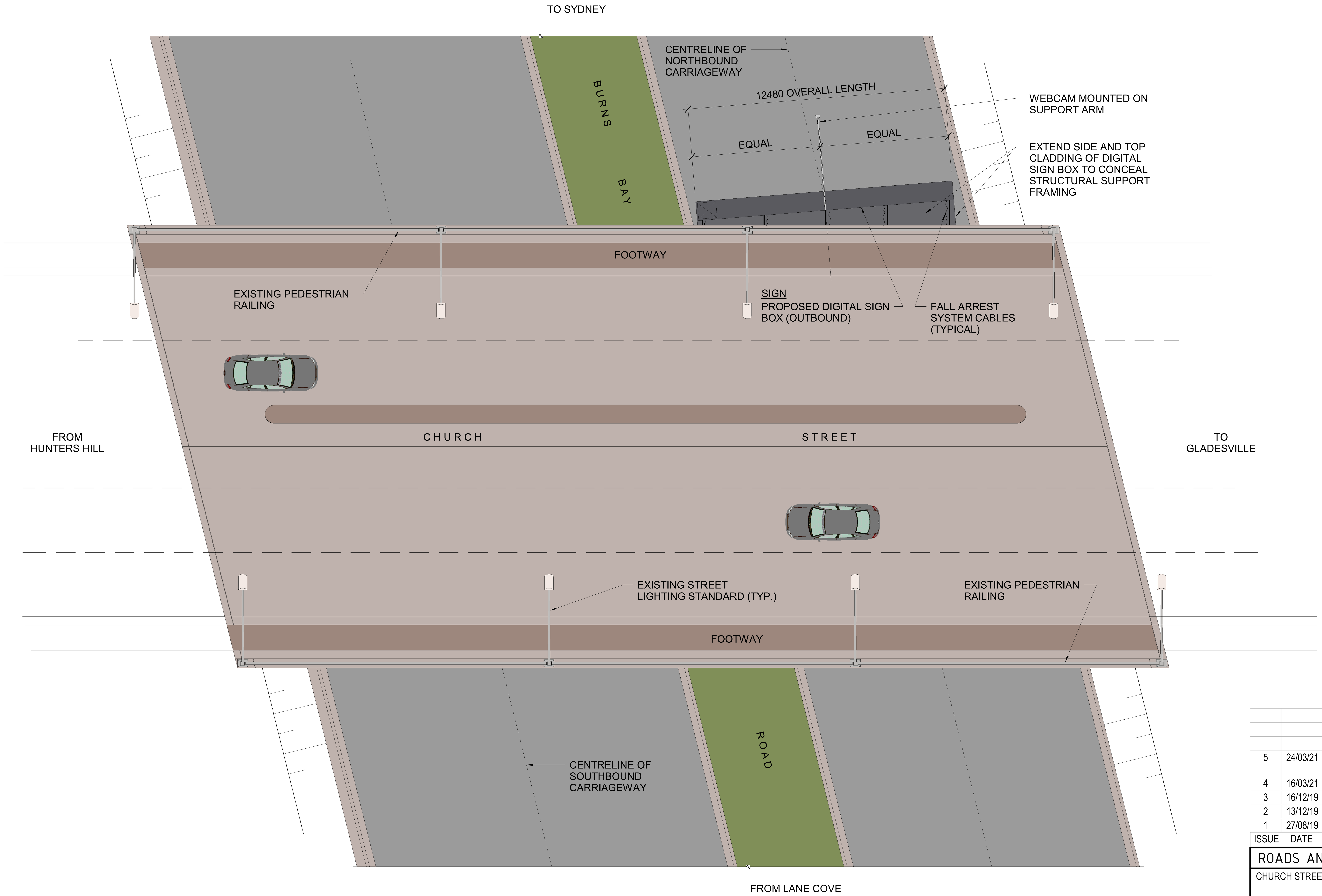
Live load on signage

Gantry	2.50	kN/m



M. Stability Check (Sliding and Overturning)

REFERENCE	CALCULATIONS			OUTPUT
	Calculated Forces			
	Dead load, G			
	Self weight of bridge (consider only half of length)	7530.30	kN	
	Dead Load on Signage (SW + SDL)	58.92	kN	
	Live load, Q			
	Live load on signage	105.78	kN	
	Wind load, W			
	Wind load on signage	67.70	kN	
	Wind pressure on bridge	2.12	kPa	
	Wind load on bridge	90.60	kN	
	Eccentricities			
	e1	1.20	m	
	e2	1.68	m	
	e3	11.00	m	
	e4	0.95	m	
0.9G	**Factored Righting Moment**	74,549.96	kN-m	
1.2G+1.5Q+1.5W	**Factored Overturning Moment**	574.43	kN-m	
	Factor Of Safety (Righting Moment / Overturning Moment)	129.78	> 2 Therefore, OK	
	Coefficient of friction, μ	0.40		
	Sliding force (1.5W)	237.44		
	Resisting force (μ*0.9*G)	2,710.91		
	Factor Of Safety (Sliding)	11.42	> 1.5 Therefore, OK	



DIGITAL SIGNAGE PLAN

SCALE 1 : 100

LOCALITY PLAN

NOT TO SCALE

NOTES

1. SCALES AS SHOWN.
2. DIMENSIONS SHOWN ARE IN MILLIMETRES.
3. CLADDING TO BASE, SIDES AND TOP SHALL BE 'LOCKER GROUP PERFORATED MESH R02411' - 2.0mm ALUMINIUM SHEET, OR APPROVED EQUIVALENT. POWDER COATED PAINT COLOUR - 'MONUMENT'.
4. A FALL ARREST SYSTEM (STEEL WIRE ROPE CABLES) SHALL BE FITTED, CONNECTING THE ADVERTISING SIGNAGE BOX STRUCTURE TO THE BRIDGE SUPERSTRUCTURE.
5. THE SIGNAGE STRUCTURE COMPLIES WITH THE REQUIREMENTS OF;
   - AUSTRALIAN STANDARD AS.1170.1 - SAA LOADING CODE, PART 1: DEAD AND LIVE LOADS AND LOAD COMBINATIONS.
   - AUSTRALIAN STANDARD AS.1170.2 - STRUCTURAL DESIGN ACTIONS, PART 2: WIND ACTIONS.

ISSUE	DATE	REVISION	PREP	CHECK	AUTH
5	24/03/21	DECOMMISSIONED TELCO INFORMATION REMOVED			
4	16/03/21	PROPOSED INBOUND SIGN REMOVED			
3	16/12/19	ISSUED FOR DA APPROVAL			
2	13/12/19	SIGN SIZE AMENDED			
1	27/08/19	ISSUED FOR INFORMATION			

ROADS AND MARITIME SERVICES OF NEW SOUTH WALES

CHURCH STREET — MUNICIPALITY OF HUNTERS HILL

ADVERTISING SIGNAGE
CHURCH STREET OVERPASS
HUNTERS HILL

GENERAL ARRANGEMENT - SHEET 1

ARCADIS
ARCADIS AUSTRALIA PACIFIC PTY LIMITED
Level 16, 580 George Street, Sydney NSW 2000
Tel: +61 (0)2 8907 9000

NSW GOVERNMENT Transport Roads & Maritime Services
27-31 Argyle Street, Parramatta NSW 2150

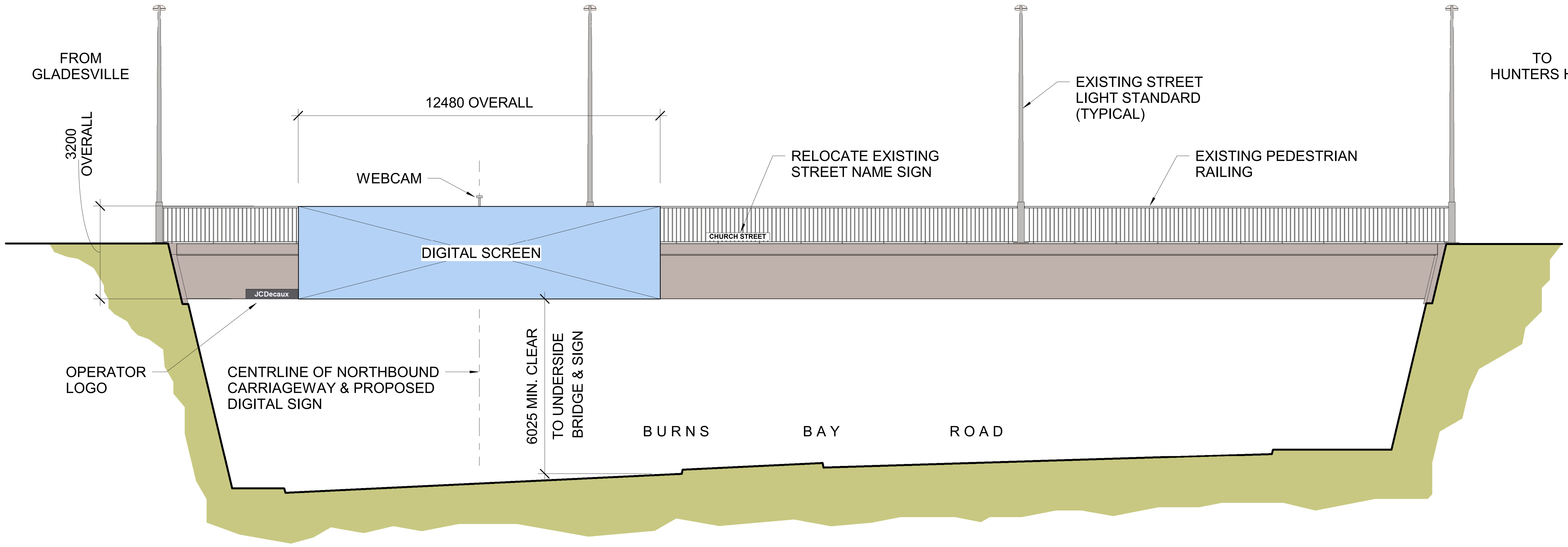
JCDecaux
Level 16, 1 York Street
Sydney NSW 2000
Australia
Tel: +61 (0)2 9557 6555
www.jcdecaux.com.au

PREPARED	CHECKED	REGISTRATION No OF PLANS
DESIGN JB		DS2019/000865
DRAWING MV		RTA BRIDGE NUMBER: BN201
APPROVED — DESIGN QA RECORDS		ISSUE STATUS: DA APPROVAL
DIRECTOR		SHEET No DA.01 — ISSUE 5

100mm on Original

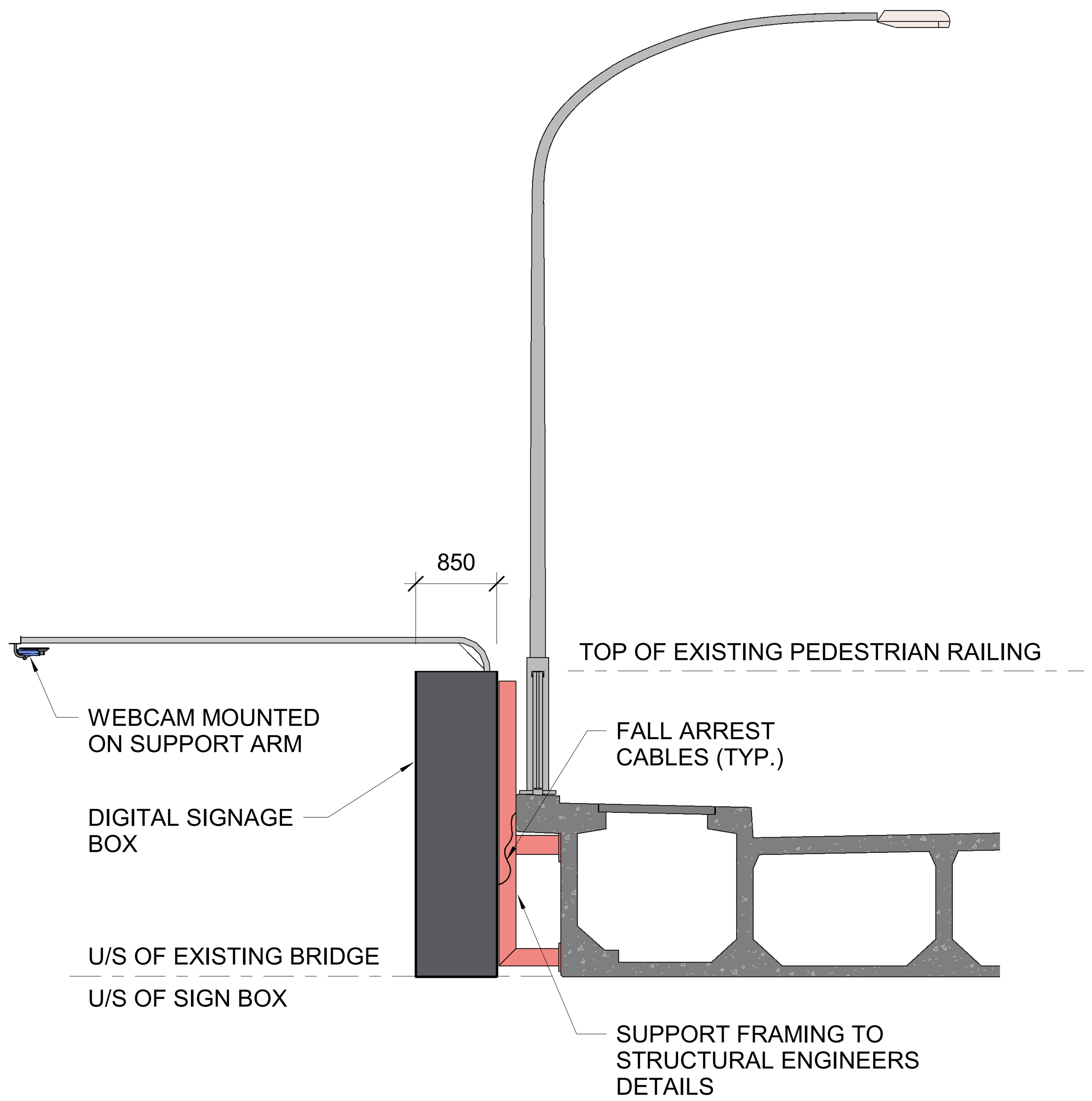
Date Plotted: 24/03/2021 8:27:24 AM

NOTES
1. SCALES AS SHOWN.
2. DIMENSIONS SHOWN ARE IN MILLIMETRES.



SOUTH ELEVATION - OUTBOUND

SCALE 1 : 100



TYPICAL SECTION

SCALE 1 : 50

ISSUE	DATE	REVISION	PREP	CHECK	AUTH
5	24/03/21	DECOMMISSIONED TELCO INFORMATION REMOVED			
4	16/03/21	PROPOSED INBOUND SIGN REMOVED			
3	16/12/19	ISSUED FOR DA APPROVAL			
2	13/12/19	SIGN SIZE AMENDED			
1	27/08/19	ISSUED FOR INFORMATION			

ROADS AND MARITIME SERVICES OF NEW SOUTH WALES

CHURCH STREET — MUNICIPALITY OF HUNTERS HILL

ADVERTISING SIGNAGE
CHURCH STREET OVERPASS
HUNTERS HILL

GENERAL ARRANGEMENT - SHEET 2

ARCADIS
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NSW GOVERNMENT Transport Roads & Maritime Services
27-31 Argyle Street, Parramatta NSW 2150

JCDecaux
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PREPARED		CHECKED
DESIGN	JB	
DRAWING	MV	

APPROVED DESIGN QA RECORDS

DIRECTOR

REGISTRATION No OF PLANS: DS2019/000865

RTA BRIDGE NUMBER: BN201

ISSUE STATUS: DA APPROVAL

SHEET No DA.02 — ISSUE 5

100mm on Original

Date Plotted: 24/03/2021 8:27:28 AM